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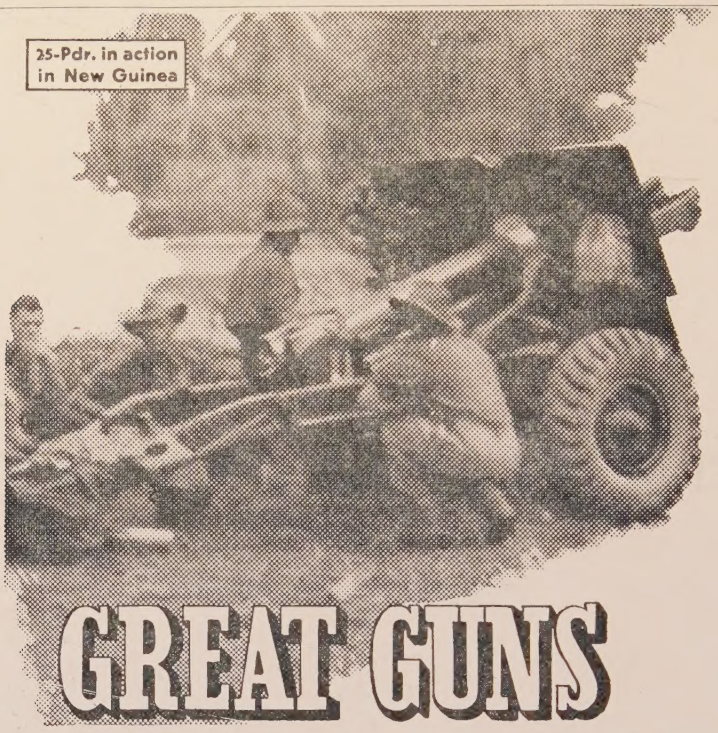

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JOURNAL
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Department of Agriculture
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Vol. 22 (Second Series) SEPTEMBER, 1945. No. 3.

Soil Erosion.

Hon. F. J. S. Wise, Premier of Western Australia.

[Whenever thinking men meet nowadays to discuss world agriculture and agricultural economics, the subject of soil erosion always takes a prominent place as in many countries this is a major problem which has already cost millions of pounds in potential value lost and will cost millions more to control.

That the Government of this State realises the importance of the danger, and has taken early legislative action to guard against the loss and desolation experienced in other States and countries is evidenced by the speech, reprinted hereunder direct from "Hansard," delivered by the Honourable the Premier (Hon. F. J. S. Wise) when introducing the Soil Conservation Bill into the Legislative Assembly on 6th September, 1945.—*Editor.*]

Reprinted from "Hansard."

BILL—SOIL CONSERVATION.

Second Reading.

THE PREMIER (Hon. F. J. S. Wise—Gascoyne) in moving the second reading said: In introducing the subject to the House, I do so with great confidence, because I am sure that the attitude of people towards the necessity for soil conservation has spread to this State to an extent that has brought home a realisation of the severity of the problem.

Awakening Public Conscience.

Public consciousness of soil erosion has developed materially in the last ten years. At about the time when the subject was very prominent in the United States of America, almost the whole world was agog because of the difficulties associated with the dust bowl of America. Although it must be stated that erosion in Nature is a beneficial process, without which the world would have died long ago, the difficulties associated with man-made erosion have indeed already become a threat to civilisation. Over very many centuries the mal-adjustment occasioned by man received very little notice, but the process nevertheless continued. The tragedies through the ages, strangely enough, have been almost completely forgotten.

Historical Examples.

I think the most striking example history has given us in connection with soil erosion is the work of the archaeologists in unearthing cities that have been buried for centuries. Certain parts of Africa and also of Asia have become world-famous on account of the discoveries of the archaeologists. The tomb of Tut-ankh-amen received such publicity that it was almost regarded as one of the wonders of the world. Perhaps it is, but I think the lesson to be drawn from it is not that it is one of the wonders of that age or of the many achievements and accomplishments of the men of those times, but rather is it a lesson to be learned of the severe destructiveness resultant upon unbridled soil erosion.

Buried Cities.

Many of the cities that have been unearthed during the last 50 years have been discovered many feet beneath the soil de-

posited during recent centuries, cities such as Antioch, cities once flourishing, once garden cities, now buried beneath feet of debris and feet of drift. If we take the case of the cedars on the Lebanon mountains, the history of which has been dealt with by many writers, we are led to the conclusion that the depriving of those hills of their timber to meet the needs of maritime interests caused the despoiling of by the discoveries of those interested archaeological work. In Mesopotamia, river Tigris, which once irrigated an e pire, is today an elevated bed, the ba of which have risen many feet from deposits of soil, simply because the trib men and people, using the timber maliciou and ruthlessly, despoiled the surface of hills, enabling subsequent rains to carry soils to the plains below. We have su

Near the junction of the Ord and the Elvire Rivers, East Kimberley. An example of deep gullying and sheet erosion.

thousands of acres of land and the entire destruction of cities with populations exceeding 400,000 people in those days. Above the very spot where the city of Antioch stood is a poor and primitive Arab village, while beneath that village the work of the men of those times is there as evidence of a very advanced stage of civilisation.

Very unfortunately, however, the real lesson that this should teach has been obscured evidence in very recent times in Egyp where large public works and tremendo dams have been rendered absolutely ineffe tive and unusable because of siltatio caused by the soils washing down from th watersheds and silting up even to hundre of feet. Those are examples which sho that soil erosion has been one of the mo potent factors in the downfall of earli civilisations.

Barren Wastes.

There are numerous instances of ruined cities lying in barren wastes that were once among the world's most fertile lands. World authorities claim that man-induced erosion is taking place in every country of the world today, except north-western Europe. In north-western Europe—including much of England—we have a striking illustration showing how land use, well controlled, can avoid many of the sad effects of soil erosion in the more recently developed and occupied countries. There has been an agriculture to suit the climate and the soil. The people have endeavoured to replenish what they have taken away. That, unfortunately, is not the case in the more recently developed countries. I shall make a quotation from a world authority on this problem whom I met very recently. I shall make other quotations at a later stage. He said—

> Today, destruction of the earth's thin living cover is proceeding at a rate and on a scale unparalleled in history, and when that thin cover soil has gone, the fertile region where it formerly lay will be uninhabitable deserts.

The writer applies that statement to many countries where farming has developed beyond safe boundaries, but even where farming has not developed beyond safe boundaries the technique and use of land has been such as to encourage not in an insidious way, but in a most obvious and serious way, the despoiling of the surface and the despoiling of the fertility of the soil. So that although we may adopt an agriculture suited to the climate we can, by the use of that agriculture, render our lands very subject to erosion problems. In almost every instance where the limit of safety, so far as rainfall and land use are concerned, has been exceeded, soil erosion has followed. As soil erosion has become a national problem in every country, it is essential in a young country such as Western Australia to heed the lessons of the past which are written in striking language in the examples before us.

Example of America.

In America, which also is a comparatively young country, it has been necessary to change the minds of the people about the management of their rural lands. Perhaps the force which brought to the world the urse that could follow from land abuse is most strikingly illustrated by the story of the dust bowl of America. World-wide publicity followed the experiences in Central America and South America after the droughts which ended in 1934. So widespread was the effect that it was extremely easy to get public opinion on the side of a Government which attempted to cope with the problem. Very large tracts of low-rainfall country had been developed. Particularly can that be said of the years following the 1914-18 war, when there was a big demand for agricultural products.

The difficulties associated with the encroachment into the low-rainfall areas is a story similar to the one that can be told of other countries where agriculture, under force of necessity of greater production, has penetrated beyond safe limits. The dust storms of America in the early nineteen-thirties left in the minds of the people—not only those immediately adjacent to the scourge, but those hundreds of miles away—the seriousness of the problem unless it was faced. It was in 1933 that America started her soil conservation service. Accurate surveys were made and, although these disclosed that serious erosion had taken place during the preceding 150 years, in many cases it had only occurred in the last 50 years of America's rural life. It was found that over 100,000,000 acres of cultivated land had been irreparably destroyed by water action, and that over 4,000,000 acres had been destroyed by wind action. In addition, very much more arable land had been partially destroyed.

Soil Conservation Service.

The Soil Conservation Service of the United States of America set out on an extremely ambitious plan. It worked out methods of control, subdivided areas of erosion hazards in particular districts and took charge of the agriculture in those districts. There were over 1,200 soil conservation districts formed and these covered over 600,000,000 acres of farm lands. I am using America as an important illustration because the successful work undertaken there is a striking example of what can be achieved if we are prepared to face the problem in a national way. America's method of approach was that the nation was much more important than the individual, and that if the individual was in the way the national need became paramount and was the one to receive attention. A recent

report shows that even during the war 8,000,000 acres has been reclaimed and, in spite of wartime conditions and difficulties associated with manpower and the like, that achievement has not only been maintained but is being progressively advanced.

Impoverishment of the Earth.

It is an unfortunate fact that both in America and in this country the early approaches of soil erosion are very insidious, barely noticeable unless one is in country where water courses and steepness of terrain make them more evident. One of the early stages in Australia, particularly in our wheat lands, is the loss of fertility due to the endeavours to get from the soil in one lifetime—or, indeed, in less than one generation—all that the soil has stored through many generations. Much of Australia's farming has been of that type. Once the structure of the soil is altered through loss of fertility, there is ample scope for the several types of erosion that are so well known. Although one can see in the gullying type of erosion a spectacular aspect, sheet erosion —which covers, even in this country, hundreds of square miles—is perhaps less spectacular but all the more effective and positively destructive.

Efforts to Allay Menace.

Many methods have been adopted in all countries to allay this menace. Contour farming, dams, cross gullies, wind-breaks and all sorts of mechanical devices have been used in an attempt to control the menace in places in this country where it has properly begun. The destruction of forest at the head waters of some of our rivers in Australia has set in motion something very difficult for man to stop. There are evidences of this for anyone to see who is privileged to travel far enough abroad in this continent, far enough away from home in the steep slopes of the Atherton Tableland or the Eungulla Tableland behind Mackay in Queensland, or in the hills near Scotsdale in Tasmania, and even in parts of the now bracken-covered hills in Victoria. In these places are to be found striking lessons as to what should be the limits of man's enterprise in his endeavour to farm steep slopes. There are many outstanding examples of that type of destruction. The denudation of the steepest slopes of all their timber, some attempts at cultivation for some years, and then abandonment because of the impossibility of getting an implement to work on such slopes—this has been the procedure.

One year's soil erosion at Tambellup in the wet winter of 1926.

It is very unfortunate that the story of forestry in the early days of this country furnishes striking indication of the rewards that a country derives from one generation of greed. In 1936, Australia had had so much publicity from concerns oversea that a public conscience was awakened in regard to the menace of erosion in this country, and in that year a soil conservation service was set up in each State. Organisations established in New South Wales, Victoria and South Australia did valuable work in stocktaking, in awakening the public to the danger, and in early preparatory work prior to embarking on more ambitious undertakings to control erosion in larger areas.

Steep slopes, when devoid of timber and herbage, rapidly turn the rain water on to the lower fertile farm lands and gully erosion follows.

Those services have performed very valuable work in reclamation and in examining all types of controls suited to Australian conditions.

Rural Reconstruction Commission.

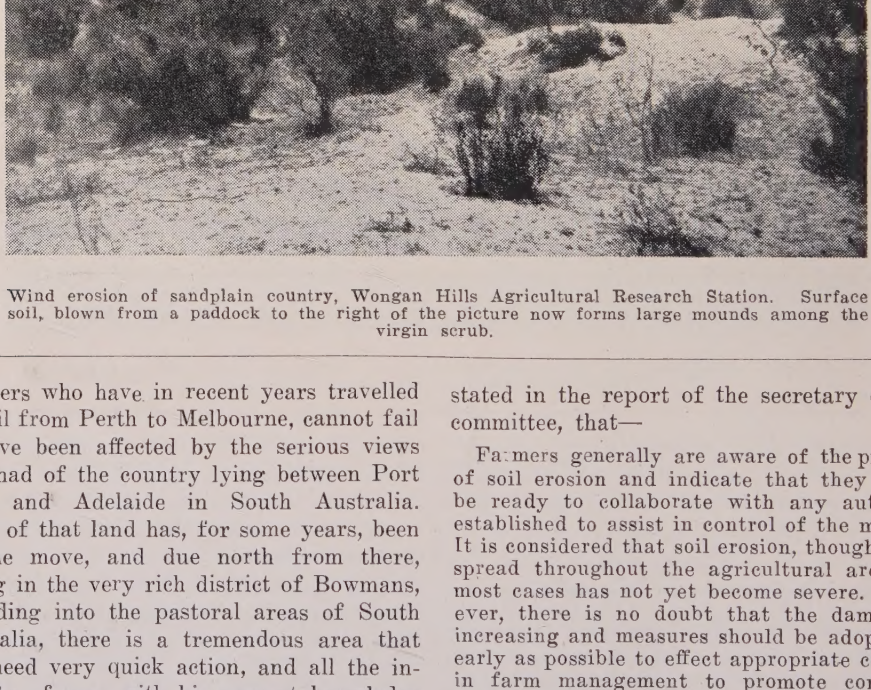
With some humility, I would recommend to members who have copies of the third report of the Rural Reconstruction Commission in their possession the reading of the chapters on the subject of erosion contained in that report. Not only will there be found therein valuable plans of areas affected by erosion in Australia, but also very candid comments on what might have been done if the Commission had had the opportunity to visit almost all the eroded areas of Australia. The Commission entered into the examination of the problem with an absolutely open mind. It was not affected by the intemperate language of the writers on the problem in other countries, but felt that it should endeavour to measure the menace on an Australian basis. Very frank comments on the subject will be found in the report. I am not sure just how widely the report has been circulated in this State. I do know that following an initial printing of 5,000 copies, there has been a demand from oversea for over 5,000 copies. I am hoping that the warning it sounds in connection with the menace in all States will serve a useful purpose towards the solving of this very vexed problem. At page 32 of the report the Commission makes these observations—

> From the erosion survey, it is apparent that in the Eastern and Central Divisions of New South Wales, some 50 per cent., or approximately 60,000,000 acres of land, for the most part of high fertility, and in moderate and good rainfall areas, are suffering actively from erosion.

Sixty million acres in New South Wales! I am certain that the percentage of Australia's population that realises this fact is very small indeed. The damage from ero-

sion is very widespread in the United States of America, but proportionately not as widespread as it is in this country. Of the area affected, 500,000 acres are classified as being seriously affected and due to water action, and over a third of a million acres are classified as being due to wind action. It is stated by the New South Wales Erosion Committee that urgent action is needed over 30,000,000 acres in that State. The Soil Conservation Board of Victoria considers that soil erosion is a major problem throughout the greater part of that State. It has caused serious deterioration of agricultural, grazing and timber lands in many and various areas there. I am certain that

sisted of the following:—The Under Se retary for Agriculture, Mr. Baron Hay, t Deputy Conservator of Forests, Mr. Stoa the Plant Nutrition Officer, Dr. Teakle, t Superintendent of Horticulture, Mr. Powe the Superintendent of Wheat Farming, M Thomas, the Officer in charge of Irrigatio Mr. Clifton, the Sheep Officer, Mr. Murra the Director of Land Settlement, Mr. Fyf and Mr. Kessell, Conservator of Forests, w was first appointed as Chairman. In h absence Mr. Fyfe acted as Chairman. Th committee in 1939 obtained returns from 3 farmers in this State, as a result of a que tionnaire sent out to 660 farmers nominate by road boards. These returns show,



Wind erosion of sandplain country, Wongan Hills Agricultural Research Station. Surface soil, blown from a paddock to the right of the picture now forms large mounds among the virgin scrub.

members who have in recent years travelled by rail from Perth to Melbourne, cannot fail to have been affected by the serious views they had of the country lying between Port Pirie and Adelaide in South Australia. Much of that land has, for some years, been on the move, and due north from there, taking in the very rich district of Bowmans, extending into the pastoral areas of South Australia, there is a tremendous area that will need very quick action, and all the ingenuity of man with his present knowledge of control of soil erosion, to overcome the trouble.

State Soil Erosion Committee.

In Western Australia we also set up a Soil Erosion Committee at that time. It con-

stated in the report of the secretary of t committee, that—

Farmers generally are aware of the proble of soil erosion and indicate that they wou be ready to collaborate with any authorit established to assist in control of the menac It is considered that soil erosion, though wid spread throughout the agricultural areas, i most cases has not yet become severe. How ever, there is no doubt that the damage increasing and measures should be adopted a early as possible to effect appropriate change in farm management to promote conserva tion.

That is an exact quote from the report o the secretary after receiving answers fro 373 farmers, and it definitely shows they ar interested, and it also shows their fears. I will be remembered that in 1940 a Roya

Commission was appointed to inquire into the pastoral industry. The question of soil erosion in our pastoral districts arose, and some 281 stations by their replies to a questionnaire, showed that in 21 cases only was there evidence of severe erosion. On 162 stations there was reported to be no eroded areas, and on 98 stations there was slight damage to land from this cause. But in the Kimberley division a reconnaissance of the Ord River Valley, made not only to effect a check on soil erosion but also in conjunction with the survey being made for irrigation prospects, showed that very severe erosion occurred there. As a matter of fact it has given the engineer, the Director of Works, graphs—some taken from the air—which will, I am sure, give all members, and not only those from the northern parts of this State, cause for considerable concern. We had aerial photographs taken not only of the Ord River basin but of the watershed of all the rivers that will run into the Ord. These photographs show strikingly just how severe is the incidence of soil erosion in that part of the State. I will quote very briefly from the introduction of this report by Captain Medcalf. He said—

A combination of air and ground observation was made and a map showing the detailed incidence of erosion in the worst sections has been compiled. Altogether some 10,000 square miles of country were reviewed, of which 1,000 are affected by accelerated erosion in varied degree from minor to severe.

Gully erosion in the Yandanooka district due to rapid run-off from bare steep hills as shown in picture above.

Mr. Dumas, considerable worry because of the possibility of severe siltation, such as has been experienced in Egypt in many of the big dams on the Nile.

Concern for Northern Areas.

I have a report by Captain Medcalf, who is a licensed surveyor, and who traversed many of the areas along the Ord River, at my direction, working under the Surveyor General. I intend to table this report, which is only typed. But in it are many photo-

Mr. McLarty: What causes the erosion in that area?

The PREMIER: That is a regular rainfall area, all of it being summer rainfall varying from 24 to 35 inches and mostly occurring on lands that have been overstocked. I can remember travelling along the Fitzroy River in 1923 when the only waters, with one exception, that were used by the station-

holders were those provided by nature in the rivers. The exception was a bore, the name of which I think was Camballum Bore—that is a memory test—on Upper Liveringa Station. That was the only bore, in those days, away from the river frontages. At that time—22 years ago—in the hundreds of miles of country between Derby and Wyndham there were few fences, practically all cattle being grazed where nature provided the water. With the exception of the Antrim Plateau, where these bores exist, that was the position obtaining. That resulted in the heavy stocking of areas where there was natural water. Whatever may have contributed subsequently to the widespread erosion in that country, I suppose that overstocking was one of the initial causes, and perhaps the principal one. If we take the areas in the middle North—those in the district represented by the member for Roebourne—we find that many properties which in 1934 carried a sheep to 10 acres and less, will never do it again. The reason why they will never do it again is because they carried them in 1934; because the country, after continuous overstocking will take more than this generation to enable it to survive!

Mr. McLarty: And the increase of vermin.

The PREMIER: The vermin in parts of the north is not plentiful now, but in those days vermin was very plentiful. On Minilya Station, which carried about 50,000 sheep, 35,000 kangaroos were shot in one year. I admit that vermin was one of the contributing factors, but let us not deny that the effects of drought and overstocking have been tremendous in our North-West. The further north we go the better can we see the lesson of erosion, and its causes, which are quite obvious to those who wish to understand the reason, by observing the condition of the country along the river frontages.

The Rape of the Earth.

To members who have not had an opportunity to read much on the subject, but who find an interest in it from a national point of view, I can commend no better book—in a world sense—than that entitled "The Rape of the Earth." This book is a world survey of soil erosion, and is written by two men, G. V. Jacks and R. O. Whyte, men who have studied the subject in all countries. While they almost gi us cause for alarm at the threat that s erosion is to this country, they point way, I believe, to the control of it, a through the control of it to the better u of the land. In this publication will found not only a thoughtful approach the problem, but a practical way of co trolling the menace in its various typ In the Bill before the House—I do not wi to bore the Assembly by over-stressi what has happened in a world sense—th has been an attempt to prepare for all t phases of soil erosion that Western Au tralia can expect.

A Commissioner of Soil Conservation.

The Bill has been very carefully draft after a close study by our own Soil C servation Committee, and after a lot time put into it by myself, in an endeavo to present to the House a realistic approa to the curbing of the problem in this Sta The proposals, in brief, can be said to that, by the appointment of a commissio of soil conservation, with a limited st attached to a branch of the Departm of Agriculture, we can launch out con ently to develop plans to realise the exi ing menace and to control it in the futu So far as I can anticipate what will done, the commissioner must be a m well versed in agriculture and thorough acquainted with the agricultural areas Western Australia. He will need to be man who can win confidence in himself a his plans in the farming districts, and fr farmers as individuals.

Departmental Co-ordination.

The Bill will be found to be in six par The preliminary section deals with defi tions and the co-ordination of vari departments likely to be interest There will be found one clause, in th first part, which is very embracing, as f as inter-departmental relationships a concerned. For example, there will not found in the Bill much dealing with t control of watercourses—that is spec cally, as such—but there will be found the first part of it, when read in conju tion with the schedule, a complete cover that and many other particulars. It e braces and works side by side with su Acts as the Rights in Water and Irrigati

Act, the Forests Act, the Land Act, and many other Acts that are mentioned in the Schedule.

The next clause, dealing with administration, places the administration of the Act under the Minister for Agriculture. The expenses of the service will be paid out of moneys appropriated by Parliament, and it is envisaged that the service will be an entity within a branch of the Department of Agriculture. Without any anticipation of who might be the Soils Commissioner, I am hoping that it will be possible for an expert and well-known officer of the Soils Branch to be the first commissioner and, until the scheme is launched, for him to have the responsibility of organisation, because at present he has the confidence of the farming community of this State, due to his past service.

Duties of Soil Advisory Conservation Committee.

In order to bring all the interests in the various departments together, it is necessary to have a man who has that confidence, as well as the soils knowledge that this officer possesses. The Bill, in its design to give to him the necessary powers, and also in the second part, arranges for the establishment of a Soil Advisory Conservation Committee. On that committee will be one member from the Department of Agriculture, one member of the Department of Lands, one of the Public Works Department, one of the Forests Department, one from the Rural and Industries Bank. One shall be a member of the agricultural community, and one a representative of the pastoralists. That committee is to consider all aspects of soil conservation, and will make recommendations to the commissioner, and to the Minister, in respect of action found necessary for controlling soil erosion. The committee will conduct investigations as required, and will make reports, with advice or with information.

Large gully formed by water erosion in the Yandanooka district. In spite of the cement and stone structure, the adjacent road is still in danger.

Conservation Service.

The next part of the Bill deals with the conservation service. In that part it will be found that soils districts will be proclaimed and, though farm management

is the responsibility of the farmer himself, that service, through the active officers of the department, will do its best not only to advise the farmer in connection with immediate problems, but—not alone through expert advice, but by visual happenings either on the particular farm or in selected areas—to convince him as to the measures necessary to be adopted in his case, and in the district's case. Regional committees will be appointed, with purely local people on them, to assist in the smaller or local problems of a given district. I am sure that active district support of this description will do much to mould public opinion, to achieve public confidence and to get the right results within a district.

Acquisition of Reserves.

A further part in the Bill arranges for the acquiring of soils conservation reserves, which gives the Minister power to acquire land and create soil conservation reserves should that be found necessary in the future. Still another part deals with areas to be known as "areas of erosion hazard." Where these areas are proclaimed and where erosion is active or likely to be active, power is given to constitute them as areas of soil erosion hazard and there the soils commissioner must be prepared to put into effect some scheme of operation or control.

The Farmers' Angle.

One other important matter prescribed in the Bill in three places is one I hope the House will applaud, and it is an attempt to deal with the farmers' angle very generously. For example, if a farmer does not wish his property to be included in an area of soil erosion hazard or, as set out in another part of the Bill, if he does not wish that certain work shall be undertaken on his property, he has the right of appeal to a local court. With regard to expenses, whether he is successful with his appeal or not, provided his appeal is not frivolous or vexatious and provided he has a case, there shall be no costs given against him. What we are anxious to do is to achieve in the first instance public confidence not only in individual cases to control the menace but in a national way to have public interest created, to show that this legislation is not designed to harass or to insist unnecessarily but rather to encourage and to educate. On the other hand, I stress the point that should erosion ever become the menace to this State that it is in other parts of the Commonwealth, every recourse should be taken by authorities in the interests of the nation as against those of the individual.

Preservation of Trees, etc.

In a further part of the Bill will be found authority for appropriate action to be taken to preserve trees, shrubs and other vegetation on private property where their removal may give rise to the danger of soil erosion. I would like to mention an aspect that has been apparent to many members of this Chamber and which has induced soil erosion in districts here because of the actions of certain Commonwealth departments. Every member can see roads where wonderful avenues of trees have been destroyed to permit telephone wires to be erected.

Members: Hear, hear!

The PREMIER: One striking example is the beautiful avenue that could be seen between Walebing and Moora, where there is no longer an avenue. In the districts of the member for York, the member for Mt. Marshall and the member for Avon will be found examples where soil erosion has been induced in the first instance because of the destructiveness and thoughtlessness shown by those who have wielded the axe in cutting down trees mercilessly in order to run telephone lines through the country.

Mr. Perkins: Notwithstanding vigorous protests by the local authorities.

The PREMIER: And also notwithstanding protests by the Government. I sought to include in the Bill a provision that would give us some control over that phase. When I found that our Parliamentary Draftsman said it was quite useless for me to attempt to include any such provision in the Bill, I wrote him a minute on the subject in order to obtain from him an opinion that I could quote for the information of Parliament, because this question is likely, in our outer wheatbelt areas particularly, to worsen the position through the activities of people who are so fond of wielding the axe. Under yesterday's date the Solicitor General submitted the following opinion to me:—

1. Referring to the question submitted to me whether or not provision can be made in the Bill to prohibit, regulate or control the

cutting of timber by Commonwealth authorities, when such cutting of timber may prevent soil conservation or aggravate erosion.

2. Section 109 of the Federal Constitution enacts that when a law of a State is inconsistent with a law of the Commonwealth, the latter shall prevail and the former shall to the extent of the inconsistency be invalid.

3. Sections 84 to 87 inclusive of the Commonwealth Post and Telegraphs Act 1901-1934 confer on the Commonwealth express power to cut down timber and excavate soil from any land in connection with the construction and maintenance of telegraph lines; the Commonwealth Defence Act contains similar express provisions in connection with the construction and maintenance of fortifications and other defence works; and doubtless the same provisions are contained in many other Commonwealth Acts conferring express powers in connection with the construction and maintenance of other Commonwealth works.

4. It will be plain to you therefore that in view of Section 109 of the Federal Constitution any provision included in the Soil Conservation Bill which in its operation may in any way interfere with the enjoyment by the Commonwealth of any of the express powers aforesaid contained in the Commonwealth Acts mentioned would be invalid.

5. In these circumstances, the only alternative will be to seek some co-operative arrangement with the Commonwealth authorities.

The member for York mentioned a moment ago that no protest had induced them to adopt any attitude of consideration.

Mr. Mann: Nor even commonsense.

The PREMIER: The Commonwealth Government has, in the last five years, expressed itself as particularly interested in this problem in a national sense. It has been discussed at meetings of the Agricultural Council and at Premiers' Conferences, and I am hoping, as I have no reason to doubt the Solicitor General's point of view, that we may achieve the assistance which the Commonwealth has refused to give us in the past despite strenuous protests, and that we may achieve it somehow by co-operation and instructions from one Commonwealth department to another.

Public Interest Invited.

I feel, without labouring this subject any further, that if we can arouse public sentiment upon this very vital problem so that no person can be expected deliberately to threaten the existence of his own property or neighbouring properties, we can at this stage in Western Australia do much to avoid the sad experiences of other parts of the world.

Mr. McDonald: Would it not be convenient to include in this Bill measures against the encroachment of salt in agricultural lands?

The PREMIER: I think salt is a very different problem. It is a menace in many areas, again because of the raising of the water table by the destruction of timber, but this is something that I think must be treated separately. In fact it is being treated separately, and it is being treated successfully by the research officers of the Department of Agriculture. Research has been undertaken in certain districts, and methods are being evolved which are showing great promise respecting the control of salt in many of our valuable lands.

Mr. Perkins: Where are those areas, in the South-West or in the eastern districts?

The PREMIER: In the eastern areas, and in the northern areas from Northampton to Mullewa where salt is very prevalent in places. I feel that unless the incidence of erosion is checked, we might have a repetition of the experiences of other countries. Although this Bill may be considered to be, in some respects, in advance of the needs of today, I think it will be found to include all the requirements for controlling the menace, fairly and reasonably, by the farmers in co-operation with the Government, and that it will meet the necessities of today and tomorrow.

Swelled Head in Rams.

C. R. Toop, Senior Veterinary Surgeon.

A disease of rams popularly known as "swelled-head" or "big-head" is from time to time encountered during the summer and autumn months. Young rams and weaners principally become affected. The condition is almost entirely confined to rams of the horned breeds. Outbreaks which have come under notice in this State have occurred only amongst Merinos and Dorset Horns. The disease results from the infection of wounds about the forehead sustained by the animals when fighting. The micro-organism which infects these wounds is a common inhabitant of the soil. The disease is characterised by an oedematous or dropsical swelling of the head which in consequence becomes enormously enlarged. The condition is highly fatal and the majority of affected sheep die within two or three days of the onset of symptoms. Although the percentage of rams which may become affected is usually small, rarely exceeding five per cent. of the flock, the disease may nevertheless become a matter of serious concern particularly to the stud breeder on account of the high value of individual animals which may be involved in the mortality. Affected rams do not respond to treatment of any kind but the disease may be prevented by vaccination.

Swelled-head in a young merino ram.
(After Bull.)

SYMPTOMS.

Rams of all ages may become affected. The disease, however, is most frequently seen in weaners which appear to be less resistant to infection than are older rams. Moreover, weaners are usually allowed to run in fairly large mobs and at this age are more prone to indulge in the pastime of fighting than are more mature animals. The earliest symptom consists of a slight swelling beneath the lower jaw which rapidly increases in size until at the end of twenty-four hours the head may be distended to twice its normal size. The swelling involves the lower jaw, throat, nose, face, eyelids and ears and may in some cases extend to the upper portion of the neck. At this stage the animal is unable to eat or drink and spends most of its time lying in the normal resting position. As the result of the swelling,

the eyelids are completely closed and a purulent discharge is usually observed. The eyes, however, when examined after parting the lids are normal in appearance. Respiration is increased and in some cases is accompanied by snoring. In the majority of cases death occurs within two or three days after the onset of symptoms. Recovery may occur in some of the less severe cases.

The treatment of affected animals offers no prospect of success. Successful results have sometimes been claimed from the free incision of the swellings beneath the jaw, but there is little doubt that cases treated in this manner were of the milder type and that spontaneous recovery would in any case have occurred.

POST MORTEM APPEARANCES.

On incising the swelling the subcutaneous tissues, i.e., the tissues immediately beneath the skin, are seen to be infiltrated with a clear straw coloured fluid which exudes freely from the cut surface and coagulates to form a gelatinous mass upon coming into contact with the air. The deeper muscular tissue is normal in appearance. The thorax or chest cavity contains a large quantity of the same straw coloured fluid. The pericardial sac which encloses the heart, also contains an excess of fluid. No other changes of note are observed at post mortem.

CAUSE.

The disease is caused by a micro-organism known as *Clostridium oedematiens*, which is widely distributed in nature and is frequently found in the soil of farm lands. These organisms gain entrance to wounds in the region of the forehead and bases of the horns where they become established and multiply, setting up the characteristic changes in the tissues already described. The wounds are often quite small and insignificant and their presence may be overlooked unless a careful examination is made. Mortalities in rams resulting from "swelled-head" appear to be confined to the dry period of the year, occurring particularly during the autumn months. Outbreaks of the disease have not been observed during winter or spring when the soil is moist and covered by a good growth of green herbage. This rather suggests that the infection of the wounds results from contamination by dust containing spores of the causal organism.

DIAGNOSIS.

The fact that the disease is confined to rams and more particularly young rams, will usually serve to distinguish "swelled head" from other diseases. Light sensitization is probably the only condition with which it is likely to become confused. Light sensitization may be induced by the consumption of a variety of plants which under certain conditions form a substance in the blood which sensitizes the body cells to sunlight, resulting in the formation of oedematous (containing a watery fluid) swellings in the skin and underlying tissues. Sheep suffering from light sensitization may show considerable swelling of the head, but this is accompanied by dermatitis or inflammation of the skin, which may cause considerable irritation. Vesicles and pustules which subsequently rupture and discharge make their appearance on the affected skin, which in consequence becomes covered with crusts and scabs. In severe cases sloughing of the superficial layers of the skin may occur. The condition may also affect the lower portions of the limbs, and the backs of newly shorn sheep. In contrast with "swelled-head," which is largely confined to young rams, light sensitization may affect sheep of both sexes and all ages. Moreover, when affected sheep are removed from the offending pasture and placed under cover out of the direct rays of the sun, recovery usually occurs. Cases of "swelled-head" rarely recover irrespective of treatment.

PREVENTION BY VACCINATION.

Vaccination provides the only practical and reliable method of prevention. Black disease vaccine prepared from cultures of the organism which causes the disease is used for this purpose. The dose of this product for the sheep is 2 cc. which should be injected beneath the skin of the bare area on the outer surface of the brisket. A single injection of the vaccine confers a strong and lasting immunity which may be relied upon to protect the animal from infection for at least one year after vaccination. A very high degree of immunity is developed fourteen days after the injection, the maximum being reached at about twenty-one days. On properties on which the disease is known to occur, rams should be vaccinated at the beginning of summer, which will provide them with adequate protection during the ensuing 3-4 months when they are exposed to the greatest degree of risk. Ram lambs could, if found convenient, be inoculated at the time of weaning. In passing it is interesting to note that the same organism (*Cl. oedematiens*) which causes swelled head in rams also causes "black disease"—a braxy-like disease, which is responsible for serious mortalities in sheep in Eastern Australia. "Black disease," however, occurs only in association with infestation by the liver fluke. Fortunately the liver fluke does not occur in Western Australia, which in consequence is also free of "black disease." The same vaccine protects against both diseases.

State Agricultural Education.

W. SOUTHERN, Principal, Muresk Agricultural College.

CONSIDERABLE doubt appears to exist as to the functions of the three State-controlled educational institutions which are concerned with agricultural training and a short review of them will be of assistance to farmers and others who are interested in the training of their sons for agricultural pursuits.

The institutions are:—

(a) Narrogin School of Agriculture, Narrogin, W.A.

(b) Denmark School of Agriculture, Denmark, W.A.

(c) Muresk Agricultural College, Muresk, W.A.

The first two are controlled by the Education Department. They are of similar standard. The courses are adapted to the work carried out in each district. The Denmark school, for instance, gives a good deal of attention to dairying.

The standard of education may be regarded as post-primary. Students who are aged 14-17 years are eligible for admission provided they have passed the sixth standard.

The schools afford boys from rural districts greater facilities for education, particularly along lines which will be of most value to them as primary producers. Students are given a general education and, at the same time, have the opportunity of acquiring technical skill and knowledge in handicrafts. Other subjects such as bookkeeping are also taught. Special attention is given to harness repairing, blacksmithing and carpentry.

The course is of two years' duration and approximately half of that time is spent in outdoor work. Students thus secure practical instruction in various branches of agriculture.

Applications for admission must be sent to the Education Department by a fixed date each year and are invited through advertisement in the Press. A Selection Committee considers them and successful students are notified.

When applications exceed the vacancies, preference is given to the sons of farmers.

Students must be physically fitted for farm work.

The annual fee is £32 5s.

Full details, including information concerning free scholarships tenable at these two schools, may be secured from the Education Department, Perth.

Muresk Agricultural College is the senior school in standard. It is this State's counterpart of Hawkesbury, Dookie and Roseworthy Agricultural Colleges and is controlled by the Department of Agriculture.

Those who desire to apply for admission must, before entering the college, have attained Junior Certificate standard. Applications close on 31st December, and the success of them is announced immediately after the Junior Certificate results are released.

The certificate results are not the only means by which students are selected. It must be remembered that students in country centres may not have the opportunity to cover a large range of subjects. English and mathematics may be regarded as important. Other factors such as general interests are taken into account. It can also be anticipated that those with rural interests have a strong claim.

Students must be physically fit.

Applicants who have attained a higher standard than the Junior Certificate may be admitted to the second year of the three year course, provided that vacancies exist. Such applicants should at least have a knowledge of chemistry and physics. They are judged on their merits as well as their knowledge of the first year work.

Two full time courses are normally conducted—

(a) Diploma in Agriculture.

(b) Diploma in Dairy Science.

(a) Is a three-year general course in agriculture.

The situation of the College (three miles south of Spencer's Brook) allows most types of farming operations to be carried out. Among its activities are the growing of grain, fodder and pasture crops, dairying, pig and poultry raising, orcharding, etc. Instruction in building construction, woolclassing, blacksmithing, gardening, etc., is given.

The work is arranged so that practical work and class work are held in alternate weeks. The class courses include a wide range of subjects such as veterinary science, animal husbandry, mechanics, farm management, bookkeeping and others.

(b) Is a course of two years and is designed to train students for employment in dairy factory work.

Application conditions, similar to those for the agricultural course, apply. Holders of the Muresk Diploma in Agriculture or those who have had satisfactory factory experience may be exempted from the first year of the course.

It has not yet been decided whether this course will be held in 1946.

The annual fee for either course is £47. Scholars from Government schools may be granted a boarding allowance of £30 per year if their parents have only a limited income.

Secondary school scholarship holders and those who gained "admissions" to Government high schools may have their scholarships or "admissions" renewed at Muresk.

Full details concerning Muresk Agricultural College may be obtained on application to the Principal.

Home Made Bag Branding Machine.

BASIL N. LOWE, Potato Inspector.

Realising that the manual branding of potato and other sacks is a tedious and time-consuming job on the farm, the writer has attempted to describe hereunder a simple and effective mechanical brander which should amply repay the farmer for the time spent on its construction.

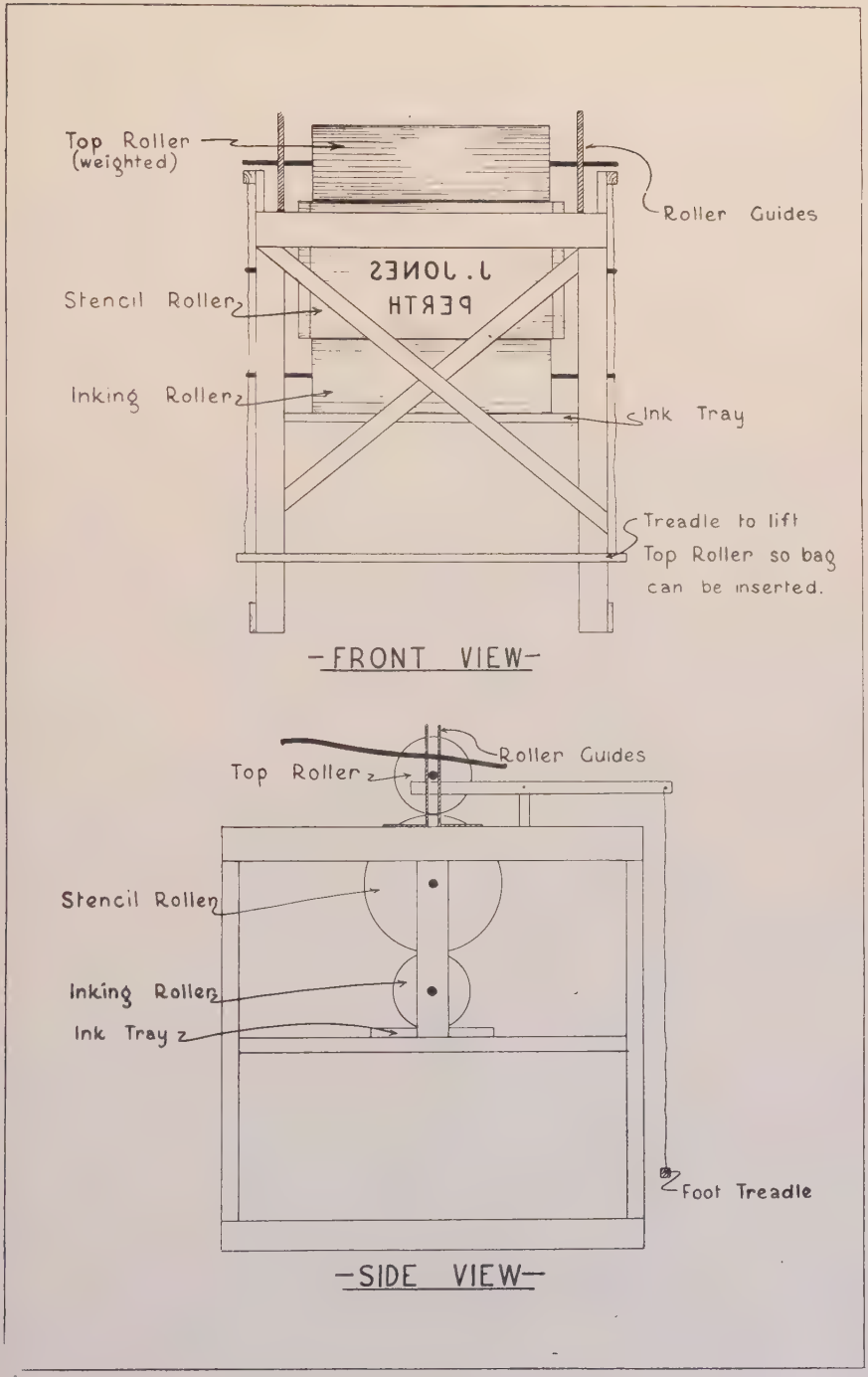
This machine has been in operation on the farm of Mr. W. S. Partridge, "White Rocks," Brunswick, for the past two seasons and has proved very successful, particularly as it can be operated by the children. It is at least four times as fast as manual branding with stencil and brush. That its construction is simple is proved by the fact that it was made entirely by the eleven year old son of Mr. Partridge, assisted by a younger brother. It was made from odds and ends of material of the type found on all farms, and it should be noted that it is not necessary to adhere strictly to any particular sizes. For instance, the frame may be of any height to suit the operator and of a width suited to the drum.

The main roller is the drum from an old thresher with the spikes removed and slats fixed lengthwise along the drum and held at each end with bands of hoop iron. The slats are used as a base for the stencil lettering and should be spaced to agree with the desired distance between the lines of lettering on the brand.

The top roller comes from an old lawn mower—one of the heavy cast type, but any roller of sufficient weight to exert plenty of pressure on the lettered roller would be suitable. The lower, or inking roller need not be heavy and is covered with felt or other material suitable for holding ink. This roller revolves in a tray in which is placed the branding fluid, and acts as a conveyor of ink to the lettered roller.

Lettering may be made from scrap rubber, preferably about ¼in. in thickness, and tacked or glued to the slats. Care should be exercised, when attaching the letters, to see that they are placed in a reverse position and appear as the branded bag would if held before a mirror.

From the diagrams, which are only sketches to convey the method of assembly, it will be noted that the top roller spindle runs in guides instead of bearings. This allows the roller to be lifted by the foot treadle. These guides may be made from



strap iron and long enough to permit of the top roller being lifted to insert the bag to be branded, and allow about three inches to be bent at right angles to fasten the guides to the frame.

After the tray has been filled with ink, it is advisable to turn the rollers a few times to ensure that the letters are thoroughly inked before commencing operations. To operate, the treadle is depressed to lift the top roller, a bag is inserted, the treadle released, and the bag pulled through. It may be necessary to experiment with an old bag to find the correct position in which to have the lettered roller in order that the brand may occupy a central position on the sack.

Although not fitted to the machine at Brunswick, it appears that some type of scraper to remove excess ink from the inking roller could be used with advantage.

Citrus Tree Pruning.

V. CAHILL, Horticultural Instructor.

The pruning of Citrus trees is a subject in which all Citrus growers are interested, and there are many divergent opinions expressed regarding the procedure. Growers are always keen to know the system which would best suit their own trees. For many years there has been a controversy as to whether or not pruning is necessary.

Fig. 1.
Newly planted tree after pruning.

The problem of pruning Citrus is not as well understood as that of pruning deciduous trees, and the orchardist must give the problem rather more than just a superficial study to understand the principles which affect growth and fruit production.

To have a successful Citrus orchard, much depends on the location, as soil conditions and climate have a tremendous effect on the growth of the trees. Also, such other factors as good cultivation, adequate fertilisers, efficient spraying, pruning and general care are all necessary. Citrus trees, however, will thrive and bear fruit on many different types of soil, but the best results can only be secured by close study and work.

Fig. 2.
Five-year-old Valencia after pruning.

Pruning should be considered a fundamental operation, as it is concerned with the regulation of food supply and storage. It is also a valuable aid to the grower, when carried out intelligently, in securing profitable fruit crops over a longer period of years.

Some of the principal reasons for pruning can be stated as follows:—

(a) At planting time the young tree must be pruned as a compensation for the loss of many roots, and to secure a good framework.

(b) All undesirable limbs on older trees are best removed, while the thinning and cutting away of the lower growth must be done to meet economic and cultural requirements.

(c) The removal of damaged and spent parts of the tree to prevent disease infection from entering is also necessary.

(d) The renewal of old, decaying trees, as described later, is necessary if the orchard is to continue in commercial production.

(e) Spraying can be more conveniently carried out when the tree has been properly pruned.

(f) Where the disease Brown Rot is prevalent, it is necessary to remove all branches touching the ground.

Fig. 3.
Ten-year-old Navel tree pruned.

Whether light or heavy pruning is done depends on the age and condition of the tree.

The following photographic illustrations and observations explain in some detail pruning methods and experiments which were carried out by the writer, and have proved successful in the Mundaring district.

MANAGEMENT OF NEWLY PLANTED CITRUS TREES.

Figure 1 illustrates a newly planted tree after pruning, and it can be seen that three main arms have been left on which to build the future framework of the tree. From three to four limbs should be selected, as evenly spaced as possible, to secure a balanced tree. At planting time the top of the young Citrus tree must

be pruned to balance the loss of many roots caused when it was lifted from the nursery. Also, it is important to shorten back bruised and broken roots by clean pruning cuts.

During the following season vegetative growths will develop on the trunk and main arms of the young tree, but only those shoots which are required as framework branches should be retained. All unwanted shoots should be rubbed off soon after their development, but care must be taken that sufficient are retained in a weakened form by pinching back, to protect the trunk from sun-burning.

Fig. 4A.
Fifteen-year-old Navel before pruning.

Fig. 4B.
The same tree after pruning.

After the first pruning, many of the young trees will develop a good framework, and grow into shapely trees. On these very little pruning will be necessary for several years, but they should be gone through annually for the purpose of removing any misplaced limbs, suckers and dead wood. An annual pruning during the early years of the life of the tree tends to prolong the period of vegetative growth, and to slightly increase the time required for the tree to come into bearing.

MANAGEMENT OF YOUNG TREE UP TO BEARING STAGE.

Figure 2 illustrates a five year-old Valencia after pruning. The object of pruning this type of tree is that of guiding and developing a strong framework, and preserving a balance between vegetative vigour and fruitfulness.

MANAGEMENT OF YOUNG BEARING TREE.

Figure 3 shows a 10 year-old Navel tree pruned. When pruning a bearing tree it is important to realise that all Citrus trees produce their bearing wood during the previous season's growth. The grower must determine whether the new growth is sufficient for the following season's crop, and if not, then there is the necessity for it to be stimulated by pruning.

Fig. 5.
Twenty-five-year-old tree thinned.

Fig. 6.
An old tree twelve months after treatment.

It is recommended that all bearing Citrus trees receive an annual light to moderate pruning. The habits of growth of the different main types of Citrus grown are interesting to observe. Navel and Grapefruit trees tend to develop

Fig. 7.
A 20-year-old Emperor Mandarin.

Fig. 8A.
Decadent lemon tree before pruning.

to a large degree a pendulous habit of growth, forming a series of overlapping tiers; the Valencia, Mandarin and Lemon trees generally grow more upright. Where the trees are very weak it is advisable to ascertain, before pruning, whether or not some disease is the cause of the weakness.

Fig. 8B.
Same tree after pruning, showing it skeletonised.

MANAGEMENT OF MATURE TREES.

As the Citrus tree ages, it forms an outer shell of compact foliage as shown in illustration 4A. In time the bearing wood loses its vigour, and evidence shows that judicious pruning treatment stimulates the production of new fruiting wood.

Fig. 9.
An old Navel tree similarly treated as the lemon tree in Fig. 8B.

Fig. 10.
An unthrifty Valencia tree severely pruned.

Fig. 11.
A view of severe skeletonising of Navel and Valencia trees.

It is important that the interior of the tree should be supplied with light to maintain the healthy growth of the fruiting wood. Systematic thinning is required to remove either shoots, branches, or small limbs, when they are too dense to open up the tree. In this way the occurrence of dead wood is reduced to a minimum.

The appearance of the tree after pruning is illustrated in figure 4B, which shows the same tree pruned.

When removing lower branches touching the ground, the height to which they should be cut varies according to circumstances, but in general knee height should be fairly satisfactory.

Fig. 12.
Same trees as shown in Fig. 11, taken two years after heavy pruning.

Figure 5 depicts a twenty-five year-old tree thinned. After several years of bearing, the production of many Citrus trees declines, even in well-cared-for orchards. This is often due to the lack of vigorous and healthy fruiting wood, due to spent growth. With trees in this condition the fruiting wood should be renewed and it can be done by thinning as illustrated.

When shortening branches and spent fruiting wood, all cuts should be made right back to healthy wood.

Figure 6 illustrates a similar tree to that shown in the previous illustration, which, twelve months after treatment, made excellent growth.

With some Citrus trees, particularly Mandarins, heavy and light cropping in alternate years becomes prevalent. It is suggested that proper pruning in the expected heavy year will reduce the crop to reasonable proportions.

The tree illustrated in figure 7 has been lightly pruned to reduce the expected heavy crop of what may be small and inferior fruit.

The decline of old Citrus trees as indicated in figure 8A may be due to starvation, caused by too close planting, unsuitable soil conditions, or a general lack of attention.

The following characteristics are associated with such trees—

(a) A greatly increased percentage of small sized fruits.

(b) Greatly decreased yield.

(c) Dead wood, poor growth, and dwarfed foliage.

(d) Fruiting wood weak, almost leafless, and with smaller blossoms.

Figs. 13A and 13B.
Close up views of a single tree shown in Figs. 11 and 12.

Severe pruning of trees in this condition usually promotes fresh, healthy growth, and with improved attention they may be brought back to their former productive condition. Such heavy pruning, amounting even to skeletonising as illustrated in figure 8B is sometimes necessary. Though severe, the skeletonising system of pruning is a rational method which can give satisfactory results.

Figure 9 shows an old Navel tree similarly treated as the lemon tree in figure 8B.

With old Citrus trees whose vitality seems to have diminished to a low point, the pruning must be heavier, and old and decadent limbs are entirely removed, as shown in figures 8B, 9 and 10.

Fig. 14.
Navel tree 30 years old when transplanted, and taken two years after transplanting, showing growth and crop.

This method of rejuvenating means the cutting out of all unwanted arms and cross limbs, leaving only a bare skeleton framework.

The sound arms and branches should be cut right back to healthy wood. Dormant buds will be stimulated into growth. The new growth should be thinned out to allow the circulation of air and sunlight when it is too dense.

Citrus trees should have plenty of room for growth and for cultivation, and mistakes are often made planting them too close.

Citrus trees, when close planted, may do well for several years, but after that they quickly decline. The planting distances should vary according to the location, but greater distances should always be given in the drier areas. It is suggested that under most circumstances they be planted 24ft. x 24ft. on the square system.

Several years ago a Stoneville grower was advised by the writer to use the skeletonising system of pruning on every second row of trees, and to transplant them as they were too closely planted. The 20 year-old trees were carefully lifted and transplanted out into other ground; this meant the increasing of the citrus grove from three to six acres. At the present time all these trees are growing and cropping remarkably well.

Figure 14 illustrates a Navel tree, 30 years old when transplanted, and taken two years after transplanting, showing growth and crop.

With Citrus trees that have been injured by frosts, the pruning should be delayed until the extent of the injury is determined, which would normally be towards the beginning of Summer. Pruning during late Summer or early Autumn renders the new growth produced liable to frost injury in susceptible districts.

It is suggested that the pruning of Citrus trees be done during September, October or November.

In conclusion, the object of pruning Citrus trees is to establish a good framework, to maintain balance between vegetative growth, and fruitfulness, and to reduce the susceptibility of the trees to disease.

There are a great many old Citrus orchards that the writer believes could be rejuvenated, if they were properly pruned and given the necessary care and attention.

Caseous Lymphadenitis ("Cheesy Gland") of Sheep.

B. BIGNOLD, Government Veterinary Surgeon.

Introduction.—Caseous lymphadenitis is a disease of sheep in which hard abscesses full of thick cheesy pus form in various parts of the body. It is called "lymphadenitis" (a word meaning inflammation of lymph glands) because these organs are usually affected. "Caseous" refers to the cheesy nature of the pus formed.

Although the health of the sheep is seldom seriously affected, the disease is economically important because affected carcases are not accepted for export.

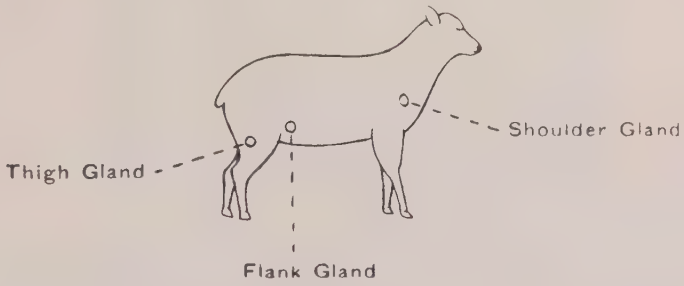


Fig. 1.
Sketch of sheep showing lymphatic glands most commonly affected with caseous lymphadenitis.
—*C.S.I.R. Journal.*

Prevalence.—Old sheep which have been frequently exposed to infection are naturally more often affected. In one series of investigations 2½% of lambs under six months were affected; in sheep 1 to 2 years 12½%, and sheep over 5 years 60%. Over the last twenty years the number of sheep found affected at abattoirs in W.A. has steadily increased.

Cause.—Caseous Lymphadenitis is caused by a special microbe found in sheep in most parts of the world, but rarely infecting any other animal. It can survive indefinitely in soil and droppings round shearing sheds and yards which are moist and not exposed to sunlight.

Method of Infection.—The germ enters through skin wounds such as are inflicted at lamb marking and especially at shearing. There are two factors concerned in the production of the disease, skin wounds and exposure to the germs. This is illustrated by an experiment in which two groups of sheep were shorn after which one was drafted through the pens and yards and the other run directly into clean paddocks. Although both groups received an average of over five wounds per sheep, 40% of the group going through the yards developed the disease, and less than 5% of the other group.

Progress of the disease in the body.—Most people know that blood is pumped by the heart through the arteries to various parts of the body and returned to it via the veins. Not everyone realises however that some of the blood serum oozes

Fig. 2.
Enlarged shoulder gland (prescapular lymphatic gland) almost ready to burst. Note shedding of wool over abscess.
—*C.S.I.R. Journal.*

out through the walls of the tiny blood vessels, being then called lymph, and after bathing the tissue cells, is collected again in the lymph vessels. These are like veins, but have glands along their course which filter off and destroy any germs washed from damaged tissues. The lymph is finally returned again to the blood stream.

When a shearing cut is soiled with infected dirt, the germs are carried to the lymph gland. Here occurs a critical battle. If the cells of the gland can overcome the invading germs no harm is done; but if the germs multiply too quickly they form an abscess of thick pus of a slightly greenish tinge. It increases slowly in size, and is enclosed in a tough fibrous capsule, which is the body's attempt to seal off the invaders. If any germs break out they are carried on to the next gland, and may form another abscess, and so on to the heart and lungs.

Figure 1 shows the position of the chief superficial glands, and Figs. 2 and 3 show a shoulder and a flank gland enlarged. Figure 4 shows an abscess which has been removed and cut open. The glands between the hind legs above the udder and the cod are less often affected. Besides these surface enlargements, abscesses occur between and in the lungs, in the kidneys, and occasionally in other places. They may be found in the gland on the inside of a shoulder of mutton, and behind the stifle in a leg. In older abscesses the pus becomes less "creamy" and more "cheesy" and may finally be gritty due to deposits of lime. The glands on the surface of the body have a tendency to burst and discharge their pus, which soils the surrounding wool and contaminates the handpiece and clothing of the shearer. They are thus readily spread to the next sheep handled.

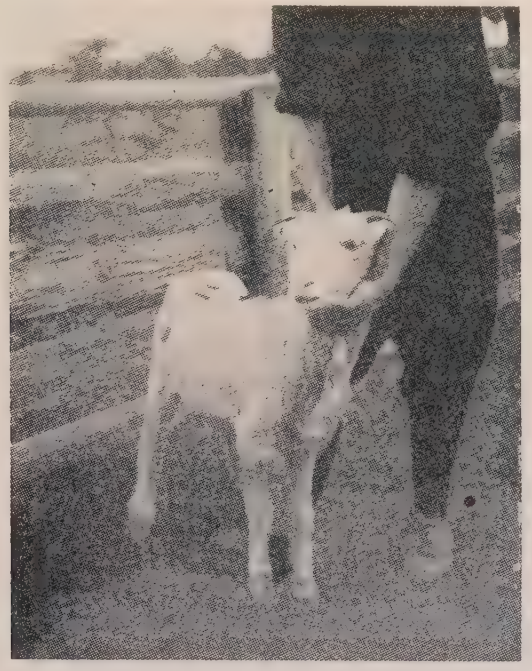


Fig. 3.
Enlarged flank gland (precrural lymphatic gland).
—*C.S.I.R. Journal.*

Diagnosis.—A hard painless swelling in one of the superficial glands is almost certainly caseous lymphadenitis.

Prevention.—Out of the preceding facts certain recommendations for prevention emerge.

(1) Old sheep having sustained more skin injuries are more heavily infected than young ones. Hence lambs should be shorn first, before the machines, hands and yards have been badly contaminated.

(2) The sheds and boards should be scrubbed with hot water and soda and then disinfected with some phenol preparation. Soil and droppings in the yards may be replaced by clean river sand, or should at least be damped down. Some pastoralists have the chutes and counting out pens concreted. Such measures incidently are also useful where tetanus occurs.

(3) Affected sheep may be segregated and used for killers, the meat being wholesome after affected glands are removed.

(4) A brush and can of disinfectant should be available for cleansing combs and cutters soiled with pus. After brushing they may be soaked in 3% Lysol and finally rinsed in water before being used again.

Fig. 4.
Lymphatic gland showing abscess. The gland is surrounded by fat and has been incised. It will be noted that the abscess completely fills the gland.
—*C.S.I.R. Journal.*

(5) As shearers nowadays have better facilities provided for washing clothes the danger from soiled pants, etc., is much less.

(6) Lamb marking should be done in temporary yards erected in a clean paddock.

Depending upon the seriousness of the disease on each particular holding, some or all of these recommendations will be found worth while.

Dairy Farm Targets.

M. CULLITY, Superintendent of Dairying.

IN the issue of this Journal for December, 1944, reference was made to the dairy target which had been allotted for Western Australia and to the programme which had been devised for individual farm targets. Owing to the poor season the total output of dairy produce was not as high as anticipated and while the target of 37,000,000 gallons of milk was set for manufactured dairy products, 29,894,760 gallons were produced. This figure is 7.2 per cent. below that of the previous year. It was pointed out in the notes referred to above that the target of 37,000,000 gallons represents an increase of 15 per cent. over the actual production of 1943-44.

It was submitted that the attainment of this target in ordinary circumstances should not be difficult owing to the fact that there was an improvement since 1939-40 when somewhat equivalent production was attained of 13 per cent. in

the number of dairy cows. It was considered, therefore, that if the cows could be adequately fed the target figure would be achieved. However, poor seasonal conditions prevented this.

During the period that the scheme has been in operation, district officers have allotted targets in consultation with more than a thousand farmers, and while it has not yet been possible to make a complete survey of the results on these farms, some figures from the South-Coastal areas are available. In these areas the target programme was put into effect by Dairy Inspector C. W. Tobin, who has submitted the information from which the following notes have been prepared.

Eighty farmers in the Walpole and Denmark districts were allocated targets. Of these, 26, or 32 per cent., realised their objectives. A further 28, however, while failing to reach the target, exceeded their previous year's production.

In Albany, of 37 farmers who were allotted targets, 17 succeeded in producing the required amount, while eight only failed to produce more than in 1943-44.

A summary for the three districts is set out in the table.

As will be seen from the table, the greatest successes have been achieved at Albany, although it was anticipated earlier that the Walpole farms would be the most successful.

The results are particularly encouraging and support the contention that excellent dairy production is possible from all of these areas.

Some interesting individual results were achieved. Mr. J. Armstrong, of Walpole, increased his per-cow production from 220 to 279 lbs. of butterfat, thereby increasing the total output of butterfat from his property by 25 per cent. Mr. W. Middleton, of Denmark, achieved an increase of 18 per cent. from 22 cows and this was the best result in the Denmark district.

The most meritorious performance, however, was that achieved by Mr. W. Wilde, of Hazelwood. This achievement was the result of Mr. Wilde's desire to respond to the appeal for increased dairy production. With no family or employed labour, Mr. and Mrs. Wilde obtained 7,521 lbs. of butterfat from 24 cows. No emphasis is necessary regarding the amount of hard work it was necessary for them to undertake. Their family has grown up and they made their own provisions for a living.

The following figures are collected from factory returns only and do not include any estimate for milk or butter used for domestic requirements or milk for feeding calves.

The number of cows milked was 24 for a total output of 7,521 lbs. The acreage of pasture available was 62, thus having a carrying capacity of 2.5 acres per cow. Despite this heavy stocking concentration, 313 lbs. of butterfat per cow were produced. The level of production on a per-acre basis was the highest for the district, being 121 lbs. The herd was milked by machine with stripping carried out by hand.

The cows were mainly of Jersey and Guernsey cross of various ages, including a number of heifers. Concentrates are used regularly in this herd, pollard and crushed wheat being made available to the cows at the rate of 5 to 6 lbs. daily. This quantity, however, is reduced as the lactations advance and production decreases. Hay was not fed in the bails but loose in the paddock. The quantity available was less than in previous years. In addition to the 62 acres of pasture, approximately 100 acres of bush country are included in the holding and all stock on the property are kept within this area.

The pastures comprise rye grass, paspalum, kikuyu and subterranean clover. Superphosphate is normally used at the rate of four tons per year while copperised super has been used in two seasons.

The holding is not totally cleared but the number of standing dead trees per acre is less than on most farms in the vicinity. The soil is a light red loam carrying jarrah and red gum over one-third of the area. The remaining two-thirds is karri and jarrah. The property is kept free of bracken fern and fallen timber.

It is interesting that Mr. Wilde considers that by further improving the herd and sub-dividing the property in smaller paddocks, still higher production could be achieved.

It is interesting also that the results for seven farms in the Hazelwood district, for which a combined target of 32,100 lbs. of butterfat was allocated, produced in all 34,077 lbs. This is a very pleasing result which it is hoped will prove a stimulus to these and other farmers in the coming seasons.

District.	Total No. of Farms.	Production, 1943–44.	Target.		Production, 1944–45.	Increase Realised	No. of Farms.		
			1944–45.	Increase on 1943–44.			Attaining Target.	Production Above 1943–44.	Production Below 1943–44.
				%		%			
Albany	37	91,349	107,850	18·0	107,578	17·7	17	28	8
Denmark	55	209,672	236,400	12·7	217,480	3·7	14	36	19
Walpole	25	112,613	124,900	11·0	123,208	9·4	12	18	7

Some Observations on Supplementary Feeding of Sheep.

R. R. RUTHERFORD, Farm Manager and Demonstrator,
Muresk Agricultural College.

In the agricultural areas of Western Australia, there is no problem in sheep husbandry of greater importance than that concerned with supplementary feeding during the dry period of the year. In the South-Western part of Western Australia, the climate is of the Mediterranean type, with practically no summer rain. Any rain that does fall is provided by scattered thunderstorms, and rarely causes pasture or crop growth. The months of November to March are typically dry and pastures are frequently dormant or scanty from approximately the end of November until the following May.

It is therefore necessary, wherever the land is fully stocked, to supplement the dry grazing with some additional fodder through the latter part of summer and the beginning of winter, or until new feed has made sufficient growth to provide a satisfactory plane of nutrition. This is of particular importance to ewes at mating, and through the period prior to, and just after lambing.

It is obvious from the condition of some flocks at the end of summer that insufficient attention has been given to the question of supplementary feeding during the period under discussion.

Underwood and Shier (J. of Agric. of W.A. Dec. 1943) showed clearly that the feeding of ½lb. of wheaten grain per sheep per day for the last 6-8 weeks of pregnancy ("steaming up") produced a highly significant reduction in the losses of ewes and lambs before and after lambing, in comparison with ewes grazed under poor nutritional conditions such as wheat stubble in late summer. Further, these workers (J. of Agric. of W.A., March, 1941) dealing with 1st Cross Border Leicester x Merino ewes found that the flushing treatment of ewes, i.e., the provision of extra food or the raising of the plane of nutrition of the ewe for a short period immediately prior to mating produced a highly significant increase in fertility, brought about entirely through an increase in the proportion of twins. These results indicate that the two important periods in the life of the breeding ewe from a nutritional standpoint are just before mating and just before lambing. At these times a high plane of nutrition is particularly necessary if good lambing numbers and low losses of ewes and lambs are to be obtained.

From the preceding information it is obvious that if the best results are to be obtained, suitable supplementary feeding must be regarded as a necessary part of flock management during the summer period, especially with breeding ewes.

Under present conditions of labour shortages the method of carrying out supplementary feeding demands careful scrutiny because time and labour required appear to be the two main factors controlling the extent to which supplementary feeding is practised.

Feed carted to the paddock in a vehicle and fed on the ground or in feeders is the most common method of feeding and can be referred to as Method 1. This has, for the feeding of "in lamb" and lambing ewes, certain disadvantages which may be summarised as follows:—

(a) Ewes leave their lambs to run to the vehicle which conveys their feed and sometimes fail to find their lambs again; further, the lambs are at this time unprotected from foxes and crows.

(b) The cost, labour and time involved often prevent the feeding being carried out.

(c) The time occupied in feeding at seeding or pre-seeding time might be more effectively employed.

(d) The wool value is lowered owing to increased dust content.

The author wishes therefore, to present his experience in the 1944 season—described as Method 2—in the hope that it may prove of interest and value to farmers.

Method 2.—At Muresk Agricultural College, in December, 1943, a crop of 50 acres of Mulga Oats estimated to yield six bags per acre lodged and was left unharvested. 303 Border Leicester cross Merino ewes of mixed ages were flushed on this area during the last three weeks of December. On January 1st, 1944, they were removed to a grass paddock containing fair natural dry herbage, where they were mated with seven Southdown rams for two months. Eight weeks prior to lambing, the ewes were returned to the 50 acres of oats, where they remained until the end of July, when 328 or 108.2% of lambs were marked. 344 lambs or 113.5% were dropped, but 16 died from various causes prior to marking.

Rains fell on the 15th May and by mid-June there was an excellent self-sown crop coming through the straw which provided a good body of green feed, although the ewes and lambs were still on the paddock.

It was particularly noticeable that only a small percentage of the oats had germinated, and that by moving the straw (which the ewes did) dry oats could be located throughout the whole area, even though quite a heavy self-sown crop was evident.

With similar ewes (unflushed) hand-fed with ½lb. of oats per sheep per day at eight weeks prior to lambing and increasing it to ¾ of a lb. per sheep per day at lambing the previous best lambing percentage marked at the College had been 89%. The lambing percentage for the district in 1944, which was a poor year, was estimated to be from 50-55%.

The following points were observed while the ewes were running and feeding under Method 2:—

1. Ewes at all times appeared well fed and contented.

2. Only two ewe losses occurred between December 1st, 1943, and August, 1944. Ewes were inoculated against Entero Toxaemia and Toxic Paralysis.

3. Twin lambs were very much in evidence.

4. Ewes did not leave their lambs.

5. Lambs were not troubled to any degree by foxes and crows.

6. Lambs were well protected from the cold, and it was quite common to see them planted in small pockets between the straw away from the wind.

7. The wool clip from the ewes was equal to, if not better than, previous clips. The ewes averaged 10.66 lbs. per head and out of this wool seven bales brought 18¼d. and four over 17d.

8. Even though a self-sown crop germinated after rains in May, which provided early green feed, dry oats could be found in quantity on the ground, by moving the straw. This was so as late as early July. The ewes made full use of this source of feed.

Method 2, therefore, can be described as the planting and leaving unharvested an area of oats equal to about one acre per 10 ewes. Such an area should provide sufficient feed for the two critical periods, namely just prior to mating and before and during lambing. This method has many advantages as indicated in the observations made over Method 1, and because of its simplicity should be within the scope of the majority of flock owners at least as a substitute for Method 1, during war-time conditions.

It should be emphasised, however, that the method of supplementary feeding suggested is the growing of a crop of oats, using portion of it as grazing for "flushing" prior to and during the early part of mating and then reserving the paddock for "steaming up" during the last 6-8 weeks of pregnancy and the lambing period. During a large part of the in-lamb period the ewe has little extra food requirements and only needs to be kept in a thriving healthy condition. In this period, the ewes should be removed from the oats paddock. If this is not done the oats could easily become exhausted and the ewes would then be on a declining plane of nutrition during the last part of pregnancy with serious losses.

D.D.T. as an Agricultural Insecticide.

C. F. H. Jenkins, Government Entomologist.

During the past twelve months, officers of the Entomological Branch have carried out a number of preliminary experiments with D.D.T. dusts and sprays against a range of agricultural pests. The dust used was a 1 per cent. concentration of D.D.T. on pyrophyllite and the spray a 0.1 per cent. D.D.T. solvent naphtha-wetsit emulsion.

It was not possible to conduct statistically planned experiments but in all cases, control plots were used as a basis of comparison. In many instances the results were so outstanding as to leave no room for doubt, but where they were in any way inconclusive, this has been stated.

Owing to the fact that the D.D.T. was not available until late November, the range of insects treated was not as great as originally planned. By this time, the main spring plagues had passed and market gardening activities had declined owing to the approach of summer.

Experiments were tried in as many parts of the State as possible with the staff available so as to observe any variations due to climatic effects.

For the sake of clarity the results are appended in tabular form on next page.

Miscellaneous.

In addition to the experiments outlined D.D.T. was used in small scale tests against several other pests. The effect of the material on insects accidentally present during field trials was also noted.

Snails (*Helix aspersa and H. pisana*): 0.1% spray solution non-effective.

Chrysomelidae: 0.1% suspension toxic.

Lampyridea: 1% dust and 0.1% solution very toxic to beetles frequenting carrot flowers treated for Rutherglen bug.

Bed Bug: 1% dust effective.

Poultry Lice: Effective when 1% dust blown under feathers.

Crusader Bug (*Mictis profana*): 0.1% spray not effective.

Lady Birds: 0.1% spray toxic.

Bees: 0.1% spray toxic.

Plant Injury.

No plant injury was observed following any of the treatments although investigations elsewhere have shown that certain plants such as young beans and melons are susceptible to some types of D.D.T. preparations.

Toxicity to Man and Animals.

British and American scientists investigating the toxicity of D.D.T. have shown that the insecticide is not likely to be any more dangerous than many other preparations at present in use. It should be used with the same care however, as arsenate of lead, and D.D.T. solutions and emulsions should not be allowed to contact the skin any more than is absolutely necessary.

Pest.	Locality.	Plant.	Age of Plant.	Treatment.	Date of Treatment.	Area or Quantity Treated.	Remarks.
Tobacco Thrips .... (*Thrips tabaci*)	Perth	Onions	Seedlings and mature	Sprayed 0·1%	7 treatments 23–11–44 to 12–2–45	2 chain rows	Little effect on thrips population which was not very heavy. (Heavy overhead watering up to twice daily).
Do. do.	do.	do.	do. do.	Dusted 1%	5–12–44	do. do.	Thrips population light and no apparent effect.
Do. do.	do.	Celery	Seed beds	Dusted 1%	4 treatments 29–11–44 to 8–1–45	2 sq. yds.	Thrips population greatly diminished on treated and control plots.
Rutherglen Bug .... (*Nysius vinitor*)	Karragullen	Potatoes ..	6 weeks from digging	Dusted 1%	8 12–44 and 20–12–44	⅛ acre ..	No apparent effect upon infestation.
Do. do.	Osborne Park	Carrots ..	Flowering	Dusted 1%	11–12–44	do.	do. do. do. do.
Leaf Hopper .... (*Empoasca terra-reginae*)	Geraldton	Rock Melons	?	do.	27–12–44	?	Complete control reported.
Do.	Cannington....	do.	Flowering	do.	28–2–45	2½ chain row	Some mortality by afternoon, very few live insects present in 10 days' time. Controls very heavily infested.
Do.	do.	do.	do.	Sprayed 0·1% solution	28–2–45	do.	Heavy mortality by afternoon. Subsequent observations agreed with dusted area. It was not possible to treat the entire area affected and due to the severe infestation on the untreated portions, the whole crop was ploughed in.
Cabbage Aphis .... (*Brevicoryne brassicae*)	do.	Cauliflowers	Running to seed	Dusted 1%	1–2–45	½ row	Some mortality but not satisfactory control. Other plants treated for cabbage moth, etc., showed slight aphis infestation but general infestation at that season was only light.
Woolly Aphis .... (*Eriosoma lanigera*)	Karragullen	Apples	Full bearing	Sprayed 0·1% Suspension	29–11–44	Bad patches on several trees	No control.
White Wax Scale .... (*Ceroplastes destructor*)	Carmel	Oranges	do.	0·1% solution	25 1–45	30 trees	No control, majority resprayed two months later with soda by orchardist.
Black Scale .... (*Saissetia oleae*)	Maddington	do.	do.	do.	31–1–45	20 trees	No control yet apparent.
Red Scale .... (*Aonidiella aurantii*)	Mundaring	do.	do.	do.	27–2–45	do.	do. do. do.
Apple Curculio .... (*Otiorrhynchus cribricollis*)	do.	do.	do.	Sprayed 0·1% solution	20–12–44	do.	Numerous dead beetles under treated trees and living specimens very scarce. Live beetles numerous under control trees.
Do.	do.	Apples	do.	do. solution	20–12–44	40 trees	do. do. do. do.
Do.	do.	Plums	do.	do.	20–12–44	6 trees	do. do. do. do.
Pear Slug .... (*Caliroa limacina*)	Karragullen	Pears	6 years old	0·1% suspension	29–12–44	do.	Pear slug killed but infestation not sufficiently bad for conclusive results.
Cabbage Moth .... (*Plutella maculipennis*)	Cannington....	Cauliflowers	Seedling to cutting	Dusted 1%	6 treatments 8–1 45 to 3–3–45	360 plants	Grown under sprinklers in midst of 5 acre patch treated with arsenate of lead. Complete control effected. Plants particularly healthy and leaves practically unblemished.
Do.	do.	do.	do. do.	do.	5 treatments 8–2–45 to 1–5–45	350 plants	do. do. do. do.

Do.	South Coogee	do.	Well established seedlings to cutting	do.	6 treatments 1-2-45 to 30-3-45	220 plants	Irrigated by furrows until hearting then sprinklers used. Grown in 3 acre patch treated with arsenate of lead. Complete control effected. Plants particularly healthy and leaves practically unblemished (treatment applied by grower).
Potato Moth .... (*Gnorimoschema operculella*)	Waroona	Potatoes	6 weeks prior to digging	do.	24-1-45	⅛ acre	No observable results.
Do.	do.	Potato tubers	Just dug	Dusted 1% before bagging	19-2-45	1 bag	Complete control up to last inspection 13-4-45.
Do.	do.	do.	do.	Dusted while being bagged	19-2-45	do.	Controls badly damaged and numerous moths emerged on tipping for examination.
Common Cutworm .... (*Agrotis radians*)	Perth	Lucerne	12 months stand, some closely cut	Sprayed 0·1%	15-1-45	3½ chain rows	Heavy mortality all instars next day, further mortality observed two following days and complete control effected. Controls very seriously affected.
Do.	do.	do.	do. do.	Dusted 1%	15-1-45	do.	do. do. do. do.
Climbing Cutworm .... (*Heliothis armigera*)	Waroona	Flax	Seed heads formed	Sprayed 0·1% solution	23-1-45	1 sq. chn.	Caterpillars rapidly left plant and crawled agitatedly about on ground. 24 hours later all plants clean; ants carrying off dead caterpillars. Control plot still infested. No further injury and crop harvested.
Do. do.	do.	do.	do. do.	Dusted 1%	23-1-45	do.	
Do. do.	Manjimup	Tobacco	Flowering	do.	Dec., 1944	½ acre	Only one treatment given due to nearness of picking date. Infestation not entirely controlled.
Do. do.	Wanneroo	Tomatoes	Seedlings to maturity	do.	8 treatments 28-11-44 to 19-2-45	549 plants	Very satisfactory control and superior to that obtained by arsenate of lead in the remaining area.
Do. do.	do.	do.	do. do	do.	6 treatments 11-1-45 to 26-3-45	....	do. do. do. do.
Cabbage Butterfly .... (*Pieris rapae*) vide *Plutella maculipennis*							
Bryobia Mite .... (*Bryobia praetiosa*)	Karragullen	Apple trees	Full bearing	Sprayed 0·1% suspension	29-11-44	40 trees	No control, resprayed a month later with white oil by orchardist with satisfactory results.
Red Spider .... (*Tetranychus urticae*)	Wanneroo	Water melons	Flowering	Dusted 1%	2 treatments 5-12-44 to 22-1-45	2 chain row	No control.
Do.	do.	do.	1 month	do.	4 treatments 29-11-44 to 8-1-45	do.	do.
Spotted Wilt	do.	Tomatoes	Fom planting out to maturity	do.	8 treatments 28-11-44 to 19-2-45	549 plants	No significant difference between treated and control.
Do.	do.	do.	do. do.	do.	6 treatments 11-1-45 to 26-3-45	250 plants	do. do. do. do.

Effect on Bees and other Useful Insects.

D.D.T. is known to be toxic to bees as well as many other useful insects, but the same applies to many insecticides and this is not a sufficient reason for condemning the use of this new material. Bees are most vulnerable when blossoming plants are treated and usually dust and spray applications can be timed to avoid the blooming period.

In addition, it is of interest to note that in Germany, field dustings with D.D.T. and arsenate of lead have shown that bees could withstand treatments three times the necessary strength of D.D.T. required to control rape beetle, but were killed with the minimum application of arsenate of lead.

It is doubtful whether the various pessimistic forecasts concerning the adverse effect of D.D.T. upon the balance of nature are well founded. It is likely that local upsets may occur and that some control programmes will have to be modified in the light of future knowledge. It must not be conceived that D.D.T. will be used in a wholesale manner over the countryside to kill friend and foe alike as such a wholesale slaughter might be fraught with dire results.

Used on comparatively small areas such as orchards and gardens, however, the effects will be very local and easily adjustable by future action.

SUMMARY.

D.D.T. did not kill all important insect pests and many mites proved particularly resistant. It was very effective against caterpillars, and cabbages and cauliflowers treated periodically with a 1% D.D.T. dust were practically free from all signs of chewing injury. Tomato plants treated from seedling to maturity showed a marked reduction in the number of "wormy" fruits, and green tomato bug infestation was greatly reduced.

Other pests against which D.D.T. gave very satisfactory results were potato moth, common cutworm, apple curculio and vegetable leafhopper.

Indications are that leaf eating orchard pests can be controlled by 0.1% D.D.T. sprays, but tests against scale insects and aphids have been inconclusive and Bryobia mite appears to be quite unaffected. Much still remains to be learned before D.D.T. can be indiscriminately recommended. Unfortunately it is toxic to many useful insects such as ladybirds, wasps and bees. Used with discretion, however, its bad effects can be minimised and its beneficial properties exploited.

Pedigree Seed.

CEREAL VARIETIES AVAILABLE FOR DISTRIBUTION.

The production of pedigree seed of the recommended cereal varieties has been a major function for many years of the agricultural research stations situated in the wheatbelt.

The relative uses of the different cereal varieties in Western Australian agriculture was discussed in a previous article in this Journal (September, 1944). This article also contains useful information regarding the growing of the individual varieties and it has been reprinted and is available as a leaflet.

The aim of the policy adopted with the distribution scheme for pedigree cereal seed is to provide as many farmers as possible with a few bags of the

varieties grown by them and which are available from the research stations. The maintaining of "stud plots" by farmers is of major importance in the maintenance of the purity of their seed supplies and the small quantities of pedigree seed obtained by them is sufficient to establish such plots.

Objections have been raised from time to time by some farmers regarding the limiting of the quantity of each variety supplied to each applicant to a few bags only. If larger quantities were made available, however, it is possible that some farmers would not obtain any supplies of the varieties required by them for quite some years. Further, the Department grows quite a number of varieties for distribution and the actual quantity produced is limited by the area which it is possible to make available for planting at each station. Actually small quantities of each variety are quite sufficient to maintain pure seed supplies on the average farm. In this connection it is pointed out that each bag of wheat woud sow at least four acres and each bag of oats or barley, three acres.

One objection raised quite often to small quantities is the extra trouble involved in harvesting small acreages; but where a farmer obtains regular supplies of the varieties he usually grows, there should be no difficulty or much extra trouble involved. With new varieties some extra work is, of course, involved but this could hardly be avoided with the introduction of a new variety on to a property and further, when new varieties are first distributed, the quantity available from the research stations is usually small in itself.

The production of pedigree seed involves highly specialised work and the actual cost is relatively high when compared with commercial production of grain. At the Merredin and Wongan Hills Research Stations "pure line" breeding plots are conducted and it is from these plots that the actual seed obtained by the farmer is produced. The "pure line" rows are maintained by selecting each year the most prolific plants having the typical characteristics of the varieties concerned. The balance of the seed is planted in a larger block known as the "accumulation block" from which the seed is obtained for the planting of the "stud" plots at the various research stations, these in their turn providing the seed for the bulk plots from which the farmers' seed is supplied.

It will thus be seen that the pedigree seed obtained by farmers is only four years away from the single selected plants. By adopting the method outlined above, it is possible to maintain the purity and high yielding capacity of the variety as it is not possible to have an admixture when single grain is used in the production of any one variety.

For distribution from the 1945-46 harvest it is anticipated that pedigree seed of seven varieties of wheat, six of oats and two of barley will be available. Short descriptions of these varieties are:—

WHEAT.

Baroota Wonder.

This variety is grown almost exclusively for hay. It is a relatively tall growing wheat and remains green to the base until haycutting time. It is very susceptible to loose smut and rust, but moderately resistant to flag smut.

Bencubbin.

This is the most extensively grown variety in Western Australia and also Australia. The straw strength tends to be weak on light land but is satisfactory

for hay. Bencubbin is notable for its high yields under inferior seasonal conditions, and although very susceptible to rust is resistant to flag smut. Its flour strength is equal to the State f.a.q.

Bungulla.

Variety trials are conducted at all five wheatbelt research stations and at three of these Bungulla is, on the average, the most prolific wheat under test.

Because of its early maturing, it usually suffers relatively little rust damage. The straw strength is satisfactory on the heavier soil types, but Koorda is to be preferred on light soils in all but the drier districts.

Bungulla is satisfactory for hay whilst the flour strength is equal to the f.a.q. of the State. It is resistant to flag smut but not to rust.

Eureka.

This variety was bred in New South Wales as a resistant wheat for planting in rust liable districts. A new rust strain has, however, appeared in New South Wales to which Eureka is susceptible. This race has not yet been collected in Western Australia.

Eureka is a stout strawed rather tall growing brown chaffed variety with translucent grain. Under slow ripening conditions the grain frequently mottles. The flour strength of Eureka is well above the f.a.q. of the State and it is resistant to flag smut. The desirable planting date for Eureka in each district would be about the same as for Bencubbin.

Kondut.

Bred at the Wongan Hills Light Lands Research Station, Kondut has yielded well, over a wide range of soil and climatic conditions.

Although not rust resistant, it gives better yields under epidemic conditions than Bencubbin and Nabawa. It is resistant to flag smut.

The straw is stout and the variety can be recommended for early planting, particularly on light land and in rust liable districts.

Kondut yields flour which is usually superior in strength to that of the f.a.q.

Koorda.

A relatively recent release by the West Australian Department of Agriculture, Koorda has yielded well on the lighter soils where its strong straw is of great value. Koorda is practically immune to flag smut and tends to be rust escaping in all but the heaviest epidemics. The flour strength of Koorda is about the same as that of the f.a.q. standard.

In yield trials on the research stations, Koorda has outyielded Merredin, a variety which it has been designed to replace.

Pusa IV.

This variety is more prolific than Comeback. It grows very vigorously and matures early. Pusa IV. is resistant to flag smut but not to rust, although it usually escapes major damage.

OATS.

Algerian.

This variety is cultivated chiefly in the Great Southern areas of the wheatbelt, where it is a useful general purpose variety. It is also used extensively for oatmeal manufacture.

Ballidu.

This variety has demonstrated its general superiority to Mulga in trials on research stations and is proving satisfactory on farmers' holdings. The straw strength and grain yields are outstanding whilst its vigorous, leafy early growth and satisfactory recovery make it suitable for grazing and recovery.

Dale.

This has given satisfactory results as a general purpose variety under a wide range of conditions. It is markedly superior to other midseason varieties in respect to straw strength and for early grazing.

Fulghum.

This is not a good general purpose variety as the straw strength is very poor. Fulghum is used principally for grazing and recovery since the notable length of its leafy growth phase prior to "shooting" enables it to be grazed later in the season than other midseason varieties. As a grazing oat the initial growth is not as vigorous as that of Dale but it is, however, very suitable for late winter or early spring feed.

The grain of Fulghum is suitable for oatmeal manufacture.

Guyra.

The principal midseason variety, Guyra is notable chiefly for its plump grain. Although a popular hay variety, the straw tends to be very coarse under favourable conditions of growth and lodging frequently occurs where crops are left for grain. Guyra is an indifferent variety for grazing and recovery since the early growth is relatively sparse and the grain yields subsequent to grazing, only fair.

Wongan.

This is notable for its vigorous early growth and strong straw. It is satisfactory as a hay variety although it is often rather short strawed. As a grain variety, it stands well but tends to shed if left unharvested after it has matured.

The vigorous early growth makes Wongan a suitable variety for early winter feed, but it cannot be grazed as late in the season as Ballidu and the midseason varieties if recovery for grain is desired.

BARLEY.

Atlas.

A six-row malting type barley introduced from California. It is also known in this State as Californian six-row barley. It is used in England for malting purposes in the production of light sparkling bottled beer and prior to the war exports of suitable samples were increasing substantially. This barley is also eminently suitable for early green feed for which purpose it is at present mainly grown; a small quantity is used for malting locally in order to maintain a nucleus of the industry. It is very suitable also for feed grain purposes, being superior in yielding capacity to Cape. The results of trials with this typical six-row barley indicate that it is superior to oats as a source of early green feed, particularly at the time of the first grazing.

Prior.

A two-row barley which is the most important malting variety grown in the Commonwealth. Although it is generally considered that Prior is a strain of English Archer malting barley, there is no record of the variety from which it actually originated or the methods by which it was developed (Scott, 1941). This variety, which proved to be much more prolific and superior in malting quality to other malting barleys, was named after Mr. Samuel Prior, of Brighton, South Australia, who obtained one bag of seed of unknown origin from an Adelaide seedsman in 1900. It was from this seed that the strain was developed, Messrs. Barret Bros., maltsters of South Australia, being responsible for its initial distribution. Prior is also a useful variety for green fodder purposes.

CONDITIONS OF SALE.

The seed will be available on a cash basis only, the exchange system, which has operated for a good many years, has been suspended and farmers will not be able to obtain seed supplies in exchange for their own f.a.q. wheat.

The cash prices for wheat, oats and barley, inclusive of freight to farmer's siding, will be:—

Wheatbelt areas:	Per bag of 3 bushels. s.	d.
Wheat and Barley	18	0
Oats	15	0
South-West areas:		
Wheat and Barley	18	0
Oats	16	6

In order to avoid disappointment in obtaining their requirements, farmers will assist considerably by noting the following directions:—

(1) All applications should be made *direct* to the Department of Agriculture, Perth.

(2) Applications should include the full name and postal address of the applicant and also the *siding* to which he desires the seed to be railed.

(3) Make early application.

(4) Forward cash remittance as soon as possible after receipt of statement of account. Statements of account are sent out in order of receipt of application.

(5) No definite reservations can be made until after receipt of the necessary cash remittance.

State Butter-Fat Records.

OFFICIAL AUSTRALIAN PURE BRED DAIRY CATTLE PRODUCTION RECORDING SCHEME.

Enquiries are received at the Department of Agriculture from time to time regarding the names of cows which hold records under the above scheme.

Press announcements are made when a record is broken but few farmers keep these for future reference. Therefore, it is felt that it would be of interest to breeders and commercial farmers if the details of the record holders were published from time to time. The following tables, therefore, have been prepared showing the highest producing cow of each breed and each age class as at the 30th June, 1945.

The records for all breeds and for Western Australian bred cows are shown also.

STATE RECORDS AT 30TH JUNE, 1945.

All Breeds.

Age Class.	Breed.	Name of Cow.	Milk.	Av. Test.	Butter Fat.	Owner.
			lb.	%	lb.	
Mature	Guernsey	Koojan Ace's Jewel 2nd	14,540	5·51	801·16	A. W. Padbury.
Sr. 4 years	Jersey	Juadine Peerless Lily 13th	11,382	6·45	734·47	Miss L. G. Hancock.
Jr. 4 years	Guernsey	Koojan Ace's Jewel 2nd	13,169	5·19	683·45	A. W. Padbury.
Sr. 3 years	Jersey	Juadine Peerless Lily 13th	10,364	6·25	648·60	Miss L. G. Hancock.
Jr. 3 years	A.I.S.	Glanavon Dahlia 7th	13,035	4·41	575·57	D. Bevan & Sons.
Sr. 2 years	Guernsey	Koojan Ideal's Jewel	12,397	5·30	657·65	A. W. Padbury.
Jr. 2 years	Guernsey	Koojan Ideal's Daphne	8,821	5·54	489·13	A. W. Padbury.

Jersey Breed.

Age Class.	Name of Cow.	Milk.	Av. Test.	Butter Fat.	Owner.
		lb.	%	lb.	
Mature	Banyule Silvermine 55th	11,759	5·76	677·97	Sabina Vale Stud Farm.
Sr. 4 years	Juadine Peerless Lily 13th	11,382	6·45	734·47	Miss L. G. Hancock.
Jr. 4 years	Camden Ariadne	8,764	6·84	600·32	C. E. Kruger.
Sr. 3 years	Juadine Peerless Lily 13th	10,364	6·25	648·60	Miss L. G. Hancock.
Jr. 3 years	Camden Ariadne	7,980	6·65	530·88	C. E. Kruger.
Sr. 2 years	Jean 2nd of Grass Vale	8,701	5·84	508·93	R. H. Rose.
Jr. 2 years	Grass Vale Northwood Eve	7,755	5·81	451·23	R. H. Rose.

Guernsey Breed.

Age Class.	Name of Cow.	Milk.	Av. Test.	Butter Fat.	Owner.
		lb.	%	lb.	
Mature	Koojan Ace's Jewel 2nd	14,540	5·51	801·16	A. W. Padbury.
Sr. 4 years	Koojan Dulcie	10,036	5·71	573·94	A. W. Padbury.
Jr. 4 years	Koojan Ace's Jewel 2nd	13,169	5·19	683·45	A. W. Padbury.
Sr. 3 years	Koojan Bo-Peep 2nd	9,639	5·69	548·93	A. W. Padbury.
Jr. 3 years	Denmark Jonquil	8,812	5·72	504·22	Denmark Research Station.
Sr. 2 years	Koojan Ideal's Jewel	12,397	5·30	657·65	A. W. Padbury.
Jr. 2 years	Koojan Ideal's Daphne	8,821	5·54	489·13	A. W. Padbury.

A.I.S. Breed.

Age Class.	Name of Cow.	Milk.	Av. Test.	Butter Fat.	Owner.
		lb.	%	lb.	
Mature	Blacklands Ettie 9th	17,523	4·43	776·91	D. Bevan & Sons.
Sr. 4 years	Hope 3rd of the Hill	13,423	4·44	606·00	W. G. Burges.
Jr. 4 years	Glanavon Doris 5th	13,443	4·62	620·66	D. Bevan & Sons.
Sr. 3 years	Glanavon Tiny 5th	14,322	4·27	612·11	D. Bevan & Sons.
Jr. 3 years	Glanavon Dahlia 7th	13,035	4·41	575·57	D. Bevan & Sons.
Sr 2 years	Glanavon Tiny 5th	13,530	4·30	581·95	D. Bevan & Sons.
Jr. 2 years	Glanavon Doris 7th	11,796	3·83	451·49	D. Bevan & Sons.

West Australian Bred.

Age Class.	Breed.	Name of Cow.	Milk.	Av. Test.	Butter Fat.	Owner.
			lb.	%	lb.	
Mature	Guernsey	Koojan Ace's Jewel 2nd	14,540	5·51	801·16	A. W. Padbury.
Sr. 4 years	Jersey	Juadine Peerless Lily 13th	11,382	6·45	734·47	Miss L. G. Hancock.
Jr. 4 years	Guernsey	Koojan Ace's Jewel 2nd	13,169	5·19	683·45	A. W. Padbury.
Sr. 3 years	Jersey	Juadine Peerless Lily 13th	10,364	6·25	648·60	Miss L. G. Hancock.
Jr. 3 years	A.I.S.	Glanavon Dahlia 7th	13,035	4·41	575·57	D. Bevan & Sons
Sr. 2 years	Guernsey	Koojan Ideal's Jewel	12,397	5·30	657·65	A. W. Padbury.
Jr. 2 years	Guernsey	Koojan Ideal's Daphne	8,821	5·54	489·13	A. W. Padbury.

Apicultural Notes and Review.

L. Blair, Government Apiculturist.

The winter that has just passed has been very wet and cold, with the result that the swarming season for bees has been retarded. The few warm days, however, brought the ubiquitous cape weed into flower, this being one of the main early sources of pollen and nectar. These are the two most essential ingredients for the well-being of the hive.

After the winter, the inmates of the hive gather fresh impetus to replenish their stores which have been depleted during the winter period when few or no flowers were available to them. When pollen and nectar starts coming in, the Queen is stimulated and lays large numbers of eggs. These mature in three weeks and the hive becomes congested and very shortly is full of young and old bees, honey and pollen. Unless this condition is remedied by the apiarist the colony prepares to swarm out by building Queen cells. When the first Queen cells have been capped over, and provided the weather continues fine, the old Queen and most of the adult flying bees leave the old home to establish a new one. At this time, they become very excited and leave the old hive usually between the hours of 10 a.m. and 3 p.m. and cluster on a nearby tree or shrub, as the old Queen, being heavy and unaccustomed to flying, does not travel very far from the old position. Scouts are then sent out from the cluster to look for suitable quarters and report back, and if not hived by the apiarist they leave for their new location.

Beekeepers are advised to inspect their hives and combs at this time of the year and replace any useless combs with frames fitted with full sheets of foundation, and, if necessary, provide an extra super. One good strong colony of bees will produce more honey and be in a better condition to carry over a drought period than half a dozen single-decker hives. This procedure will also reduce swarming considerably. Lost swarms represent thousands of good honey collectors to the apiarist.

Warning.

To those contemplating keeping bees, I would advise that it is necessary to have them in movable frame hives as this enables a thorough inspection to be made both from a production point of view and to guard against disease. This regulation has been made as a general safeguard against the spread of disease and to protect the industry generally.

Application forms for the registration of apiaries are obtainable at the Department of Agriculture, St. George's Terrace, or may be posted on request. These forms must be filled in and forwarded to the Department accompanied by the fee set out at the bottom of the form. If at any time the apiarist finds it necessary to remove his hives to another address or site, he should note that it is necessary to re-register the new site or address. This registration is not an annual one and is for the sole reason of location and inspection for disease by an officer of the Department. When registering, correct details as to situation, such as street number, district, etc., should be given. If situated in the country, number of block and remarks, so many miles N., S.E. or West of township, etc., are helpful. The registration fee payable is 1s. for ten hives and under at one site, and 2s. 6d. for over ten hives. Every site must be registered separately.

The Government Apiarist at the Department of Agriculture is always willing to assist beekeepers with advice or to examine any suspicious symptoms that may be encountered from time to time. In such cases it would be advisable to forward a piece of comb about three inches square containing suspected brood to the Department for examination. This should be free of honey and well wrapped in grease proof or other impervious paper.

Review.

Owing to the previous winter being very dry and the following summer long and hot, apiarists had only a fair year. Bush fires were very destructive and huge areas were blackened. The Karri, which has a general blooming every four years, was very late, and pollen supplies were very lean until the early rains. This, unfortunately, did not give the bees sufficient time to gather their full capacity before the winter was upon them, and in consequence less than fifty per cent. of the anticipated Karri crop was gathered.

Whilst it is yet too early to make an accurate forecast, there is every indication that the forthcoming summer will provide a record yield of honey.

Brucellosis (Contagious Abortion, Bang's Disease) of Cattle.

C. R. Toop, Senior Veterinary Surgeon.

Brucellosis of cattle, better known to the dairy farmer as contagious abortion and sometimes as Bang's disease results in serious losses to the dairying industry. This disease has a world wide distribution occurring in practically all countries in which cattle raising is practised. Western Australia is no exception in this respect. The disease occurs in all of the dairying districts and while reliable figures relating to the incidence of infection are not available it is probable that at least 10 per cent. of all dairy cattle are infected. The disease is caused by the micro-organism Brucella abortus which invades the pregnant uterus resulting in the death and subsequent expulsion of the developing calf or foetus; this occurrence being known as abortion. The aborted calf and the foetal membranes (afterbirth) which envelop it as well as the discharge voided by infected cows following abortion or calving contain enormous numbers of Brucella organisms which contaminate the pastures. The disease is spread by the consumption of food material contaminated by these organisms. Contrary to a widely held belief the bull plays little or no part in the dissemination of the disease.

With the possible exception of mastitis, brucellosis causes greater losses to the dairying industry than any other single disease. It is responsible not only for the loss of the calf but for a considerable reduction in milk yield which has been estimated at 25 to 30 per cent. Moreover, infected cows may subsequently become affected by sterility, which by itself may constitute a serious source of loss.

In addition, brucellosis in cattle has a bearing on the public health. The infection is transmissible to man causing the disease known as undulant fever which may be contracted from the consumption of milk from infected cows or from contact with such animals at the time of calving or abortion.

Until recent years no method of controlling the disease which could be regarded as effective and at the same time an economically sound and practical procedure has been available. A vaccine prepared from strains of Brucella abortus of low virulence has, however, recently been developed. The use of this product which is known as Strain 19 Vaccine offers considerable promise as a means of reducing the wastage for which the disease has been so long responsible.

CAUSE OF THE DISEASE.

The disease is caused by a micro-organism known as Brucella abortus which gains entrance to the body principally from the consumption of contaminated food material. In the non-pregnant female these organisms reach the lymph glands where they remain localised. In the pregnant animal, however, the organisms are carried to the uterus invading the foetal membranes where conditions are especially favourable to their growth and entering the body of the foetus. The multiplication of the organisms results in the development of an inflammatory condition involving both the uterus and foetal membranes and ultimately causing death and expulsion of the developing foetus. The inflammatory process is especially marked at the cotyledons or button like masses of tissue which attach the foetal membranes to the uterus and through which the foetus receives from the maternal blood supply the nutrients necessary for its growth and development. Coincident with the infection of the uterus the Brucella organisms may invade the udder where they become established and remain localised for long periods. The uterus usually becomes free of infection within a few weeks after abortion or calving. The udder infection may, however, persist for a period of months or years, during which time the organisms are excreted in considerable numbers in the milk.

SYMPTOMS.

Cows affected by brucellosis rarely suffer any disturbance to their general health. The act of abortion is the most common and frequently the only symptom observed, the discovery of an aborted foetus often providing the first indication of the existence of the disease on a property. Abortion may, however, be preceded by the usual signs of approaching parturition (normal calving) including enlargement of the vulva and the presence of a mucus discharge which in heifers and dry cows may be accompanied by a well marked increase in the size of the udder. Following abortion a chocolate coloured or yellowish discharge may issue from the vagina and this may persist for a period of several weeks.

Abortion may occur at any time after the second month of pregnancy. In the majority of cases however, it occurs between the fifth and seventh months. When abortion takes place towards the end of the gestation period a living calf may be born, but such animals are usually weak and sickly and frequently die. When abortion occurs early in the gestation period the foetal membranes (afterbirth) are usually expelled with the foetus. When, however, the foetus is aborted after the fifth month, retention of the afterbirth is a frequent complication.

In abortion affected herds sterility or temporary infertility resulting from inflammation of the uterus commonly occurs. Infected cattle occasionally become affected by swellings of the joints, particularly the knee joints. Large soft swellings may occur in one or both knees. Such a swelling is known as a hygroma and results from the invasion of the joint by Brucella organisms.

Cattle become susceptible to infection upon reaching sexual maturity. Calves are resistant to infection. When fed on infected milk calves may harbour the organisms in the digestive tract and pass them out in the droppings. This infection, however, is completely eliminated within a few weeks after the feeding of the milk has been discontinued.

SYMPTOMS IN THE BULL.

In the bull, Brucella organisms may invade the testicles and associated glands where they cause inflammation and swelling. One or both testicles may show considerable enlargement. Bulls affected by lesions of the testicles are frequently sterile.

MODE OF INFECTION.

In the vast majority of cases infection occurs by the mouth as the result of the consumption of pasture or fodder contaminated by Brucella organisms. At the time of abortion the foetus, foetal membranes and fluids which escape from the uterus contain enormous numbers of these organisms which escape to the exterior and contaminate the pastures. In addition the organisms are present in large numbers in the vaginal discharge which may persist for several weeks after abortion has occurred. Similarly in the case of infected cows that do not abort the infection may be spread by the discharge that may be voided following normal calving. The consumption of food material contaminated in this manner provides the principal means by which the disease is spread. Cows may also become infected by licking themselves or other cattle which have become soiled by these discharges.

Experimentally the disease may be transmitted without difficulty by instilling a few drops of a culture of Brucella abortus into the eye of a susceptible animal. This suggests that infection might be spread through the agency of flies. Available information does not however indicate that flies are a factor of any importance in this connection.

It has been shown that infection may occur through the unbroken skin and in view of this the possibility of infection as the result of lying on ground contaminated by the discharges of an aborting cow or from splashing with urine containing infective material cannot be overlooked.

THE ROLE OF THE BULL.

It was at one time believed that the bull played an important part in the transmission of the disease. This view however, has since been proved erroneous. While infected bulls may pass out Brucella organisms in their semen it has not been found possible to transmit the disease experimentally by mating infected bulls with healthy cows. All of the available evidence indicates that the part played by the bull in the spread of brucellosis is of little significance.

THE INTRODUCTION OF INFECTION.

The introduction of the disease into a herd is almost invariably associated with the purchase of infected cows or heifers which spread the disease to other cattle after calving or abortion. Similarly the disease may be introduced after cattle have been allowed to graze on public roads or common pastures frequented by other cattle or when they have been transferred to another property for service or agistment. Other factors which may play a part in the introduction of infection

include the transfer of an aborted foetus or portion of the afterbirth to a "clean" property by dogs or foxes or the infection of "clean" pastures by drainage or flood waters from neighbouring properties. The carriage of infection on the footwear or clothing after a visit to an infected herd is a further possibility. While none of these factors may be excluded they are probably of little importance in actual practice.

INFECTED HORSES.

The horse is susceptible to infection with Brucella abortus. Horses running with infected cattle sometimes give a positive reaction to the agglutination test and may pass out the organisms in their droppings. The organisms may also be found in the abscesses which form in horses affected by fistulous withers and poll evil. These conditions will be recognised as large painful swellings which develop in the region of the withers and poll and finally rupture and discharge pus for a prolonged period. Although horses play only a minor part in the spread of the disease to cattle the precaution should be taken of isolating or disposing of horses suffering from these conditions.

SURVIVAL OF INFECTION ON THE PASTURES.

The length of time during which the infection is able to survive on contaminated pastures depends largely upon seasonal conditions. The organisms are destroyed within the space of a few hours when exposed to direct sunlight, but may survive for a considerably longer period in well shaded areas.

Observations made at Glenfield, New South Wales, have shown that the organisms will live for less than a month during spring or summer, but may survive for as long as 100 days during winter. This would suggest that in order to free a pasture from infection it would be necessary to leave it unstocked for a month in summer and for at least three months in winter.

INCUBATION PERIOD.

The incubation period of the disease, i.e., the period which elapses from the time of exposure to infection to the time of abortion or the first occurrence of a positive reaction to the agglutination test is usually about three months, but it may vary from six weeks to as long as six months. In some cases a positive agglutination reaction does not develop until after abortion has occurred. A consideration of the length of the incubation period is important when measures for the prevention and control of the disease are being applied.

COURSE OF THE DISEASE.

Upon gaining entrance to a "clean" herd the disease frequently runs an acute course causing a large number of abortions or premature births extending over a period of one to two years. During this period a number of abortions may occur in rapid succession giving rise to the so-called abortion storm. After the storm has subsided the disease passes on to the chronic stage. As the result of exposure to infection the herd is now largely composed of animals which have developed an immunity or resistance to the disease which enables them to carry their calves to full term. Cows which have aborted on one occasion do not usually abort a second time. Two or more abortions may however occur in a small percentage of cases. Furthermore, many infected cows do not abort at all, and this is more likely to be the case if they have been exposed to infection when non-pregnant. Such resistant animals however may still harbour the infection which they are capable

of spreading to other animals following normal calving. In these resistant herds occasional abortions may continue to occur, but they are largely confined to heifers and newly introduced cows. As a sequel to the acute phase of the disease retention of the afterbirth and sterility may become a serious problem in the herd.

RETENTION OF THE AFTERBIRTH.

Retention of the afterbirth is frequently observed in herds affected by brucellosis. In consequence of the inflammatory condition caused by the organisms adhesions may occur between the uterus and foetal membranes (afterbirth) which may be retained for many days during which time putrefactive changes take place. Gross infection of the uterus occurs and this may later be followed by sterility which is a frequent sequel to this condition. The general health of the animal is usually unaffected, but sometimes as the result of absorption of toxic products from the uterus there are symptoms of sickness including loss of appetite and condition and reduction of milk yield, while in some severe cases death may occur from septic inflammation of the uterus and blood poisoning.

Normally the afterbirth is shed within a few hours of the delivery of the calf, but this may be delayed for as long as twenty-four hours and need cause no concern. When, however, the membranes are retained for a longer period than this, manual removal may become necessary and this should be undertaken before putrefaction has become marked. In the removal of the afterbirth the hand should be introduced deeply into the uterus and the membranes carefully separated from the cotyledons or button shaped areas where they are attached. Under no circumstances however, should the membranes be forcibly torn from these attachments. Following removal or attempted removal of the afterbirth the uterus should be irrigated with a warm saline solution prepared by dissolving a tablespoonful of salt in a gallon of water which may be introduced by means of a funnel to which a length of half inch tubing has been attached. The solution should not be allowed to remain in the uterus but should be siphoned off by lowering the end of the tube while it is still full.

If the afterbirth is firmly adherent to the uterus several attempts repeated at daily intervals may be necessary before it can finally be detached and this may not be found possible until the fifth or sixth day. Antiseptic precautions should always be observed which should include thorough washing of the hands and arms of the operator and the external parts of the cow with an antiseptic solution.

Retention of the afterbirth must be regarded as a serious condition and veterinary assistance should be obtained whenever it is available.

STERILITY.

In herds affected by brucellosis sterility or failure to hold to service is a frequent complication. Brucella organisms which are present in the uterus set up a chronic inflammatory condition known as metritis which may persist for a considerable period after abortion or normal calving has occurred. This inflammation is accompanied by the formation of discharges which destroy the sperms of the male so preventing the fertilisation of the ovum or egg of the female. These discharges do not usually persist for more than three or four weeks, but a period of several months may elapse before the uterus returns to its normal healthy condition. It is therefore advisable to withhold cows from service for at least three months after abortion has occurred.

In addition other bacteria may gain a foothold in the already affected uterus increasing the severity and duration of the inflammatory process and producing a more obstinate type of sterility which in some cases may be permanent. This is particularly likely to occur when the afterbirth has been retained.

Sterility resulting from inflammation of the uterus is however not necessarily associated with brucellosis and may occur in herds that are free of this disease. It is, however, much more prevalent in herds in which Brucella infection exists. Sterility of this type usually responds very satisfactorily to treatment which involves the irrigation of the uterus with a weak antiseptic solution after a catheter (irrigation tube) has been passed through the cervix or neck of that organ. Treatment of this kind however is beyond the capacity of most laymen and requires the services of a veterinary surgeon.

While metritis is by far the most common cause of sterility it may result from a variety of other conditions such as abnormalities and infections of other portions of the genital tract, nutritional deficiencies and infertility of the bull. Before any treatment is undertaken an accurate diagnosis is necessary and veterinary assistance should be sought whenever this condition becomes a problem in the herd.

DIAGNOSIS.

Brucellosis is responsible for the vast majority of the abortions occurring amongst dairy cattle in this State. Consequently when one or more abortions occur on a property the presence of the disease should be suspected and precautions should be taken to prevent the further spread of infection. Abortions may occasionally result from other causes including accidents and injuries, nutritional deficiencies and the presence of other infections, but brucellosis should not be excluded until definite proof has been obtained. The disease may be diagnosed with a high degree of accuracy by the application of the agglutination test. Blood samples may be forwarded to this Department for testing when the diagnosis is in doubt.

THE AGGLUTINATION TEST.

For the application of the agglutination test a small sample of blood is required which is collected into a sterile half ounce bottle either from the jugular vein or a small incision of the ear or tail. After collection, the sample is labelled for identification and allowed to stand until clotting occurs. The clear straw coloured fluid which separates from the clot on standing is the serum which is used for testing purposes.

In carrying out the test small measured amounts of serum are added to measured amounts of a milky suspension of Brucella organisms contained in test tubes and the result is read after the mixture has been allowed to stand in an incubator for twenty-four hours. The serum of an animal affected by brucellosis contains specific antibodies known as agglutinins which are produced within the body of the animal to assist it to resist the infection. When the serum under test contains these agglutinins the organisms become clumped together or agglutinated and fall to the bottom of the test tube forming a white deposit which is accompanied by clearing of the overlying fluid. This constitutes a positive reaction. In the case of a negative reaction there are no agglutinins present in the serum, clumping of the organisms does not occur and the suspension retains its milky appearance.

The application of the agglutination test to a dairy herd will reveal the extent of infection. It may frequently be observed that a proportion of the animals giving a positive reaction to the test have no history of abortion and that others although exposed to the disease have been able to resist infection.

PREVENTION AND CONTROL.

When a herd is free of brucellosis every endeavour should be made to maintain it in that condition. Since the disease is usually introduced by the purchase of infected cows or heifers the most favourable prospects for success in this connection exist in self-contained herds which are able to breed their own requirements and are not reliant on an outside source for replacements. In such herds new purchases should be confined to young bulls. Should the introduction of females become necessary purchases should be made subject to a negative agglutination test. Owing to the long incubation period of the disease even this procedure is not without risk. Complete reliance cannot be placed upon a single test and a greater margin of safety is provided by two tests separated by an interval of 60-90 days, the animals in the meantime being held in isolation.

CONTROL BY THE APPLICATION OF HYGIENIC MEASURES.

It has previously been pointed out that the infection is spread by the contamination of the pastures by the aborted foetus and its membranes as well as by the discharges voided by infected animals following abortion or calving. Consequently it should be possible to control the disease by separating such animals from the herd prior to abortion or calving and holding them in isolation until all discharges have ceased. In the application of this method of control maternity or calving stalls must be provided and pregnant cows and heifers must be kept under daily observation. When there is evidence of impending abortion or approaching calving the animal is removed immediately to the maternity stall where it is segregated until discharges have ceased. The aborted foetus and afterbirth are disposed of by burning or burial with quicklime. The cow is irrigated daily with a weak antiseptic or solution of salt in water in the strength of a tablespoonful to the gallon so long as the discharge persists. Precautions are taken to prevent the transfer of infection on the clothing and footwear of attendants to other members of the herd. The maternity stall is thoroughly disinfected after the animal has been removed. Although this method of control has proved effective in other countries it is rarely practicable under Australian conditions. It should however, be possible on most dairy farms to provide a small isolation paddock where cows which have aborted or are showing signs of approaching abortion can be segregated and subjected to daily irrigation until there is no further evidence of discharge. Where there is evidence that an abortion has occurred a search should be made for the foetus and afterbirth which should be burned or buried deeply, the surrounding area being liberally coated with quicklime. While this cannot be regarded as an effective means of control, it should do much towards checking the spread of the infection and may prevent the development of an abortion storm.

THE TEST-AND-SLAUGHTER METHOD.

This is based upon the agglutination test and aims at the complete eradication of the disease from infected herds. All cattle above the age of six months are included in the test and those which give a positive reaction are removed for immediate slaughter. Testing is repeated at intervals of thirty days when any additional reactors are similarly removed. When two consecutive completely nega-

tive tests have been obtained the herd is declared abortion-free and thereafter is subjected to an annual retest. After the disease has been eradicated new introductions are confined to cattle from other abortion-free herds and to cattle which have passed two agglutination tests separated by an interval of sixty days. Eradication should never be attempted during the acute stage of the disease while frequent abortions are occurring, when in consequence of the heavy contamination of the premises it presents a most difficult problem. The difficulty of eradicaton is however greatly reduced after the disease has progressed to the chronic or resistant stage.

The test-and-slaughter method has been widely applied in the United States where a nation-wide campaign for the complete eradication of brucellosis is now in progress. This scheme was introduced in 1934 as a drought relief measure for the disposal of surplus cattle and has since made remarkable progress. Compensation is paid to the owners of reacting cattle.

While the advantages to be derived from the eradication of the disease are obvious being reflected in an increase in the number of calves produced, greater breeding efficiency and increased milk production, it is a very costly procedure and there are few other countries in which it could be adopted as a general method of control. In Western Australia where the disease is widely distributed throughout the dairying districts and where the incidence of infection in many herds is high it is neither practicable nor economically possible. Under such circumstances the scope for control by test-and-slaughter is extremely limited being for the most part confined to self-contained herds in which the initial incidence of infection is low and which are so isolated that the reintroduction of infection is remote. In the latter regard the fact should not be overlooked that the abortion-free herd is composed of highly susceptible cattle and is extremely vulnerable to reinfection and that should this occur an abortion storm accompanied by heavy loss is likely.

There are many herds in which the agglutination test would reveal up to 50 per cent. or more of reactors. A large proportion of these reacting animals when retained in the herd will continue to maintain profitable production. In this connection it should be realised that brucellosis is a self limiting disease which having passed through an acute stage when abortions are frequent progresses to a chronic or resistant stage when few abortions occur. The majority of the animals in the resistant herd are able to carry their calves to full term and may thereafter be profitably maintained. Sterility, it is true may become a serious problem but this can be overcome by appropriate treatment. From a consideration of these factors it will become apparent that when circumstances render complete eradication impracticable and no other means of control are available, the alternative of allowing the disease to run its course at the same time endeavouring to check the rate of spread of infection by the application of hygienic measures is not entirely devoid of merit.

The recent development of a vaccine which is capable of reducing the abortion rate has however opened up a new and more positive approach to the problem.

VACCINATION—STRAIN 19.

Vaccination offers a practical means of control. In recent years it has been shown that cattle may be immunised against the disease by inoculating them with strains of Brucella abortus of low virulence, the best known and most effective of these being the American Strain 19. Vaccines prepared from these lowly virulent strains confer upon the treated animals a considerable degree of immunity or protection enabling them to resist the infection when subsequently exposed. In the United States where calfhood vaccination is advocated, Strain 19 Vaccine has

been subjected to extensive field trials and has succeeded in reducing the abortion rate to a low level in the herds where it has been employed. More recently the vaccine has been used in commercial dairy herds both in Victoria and New Zealand, and preliminary reports indicate that results of much the same order are being obtained. Satisfactory results have in addition been obtained from the vaccination of non-pregnant cows and heifers.

In view of this evidence the vaccination of both calves and adult animals may be advocated as a means of preventing infection and thus controlling the disease.

In the application of Strain 19 in the field it may however, be anticipated that the greatest advantages will be obtained from calfhood vaccination. Calves are vaccinated between the age of four and eight months.

While much more information derived from field experience will be necessary before final judgment is passed upon the efficacy of Strain 19 Vaccine it is obvious from the information already available that we have in this product an extremely useful weapon with which to attack the disease.

The use of Strain 19 Vaccine in this State may be anticipated, and when this becomes possible more detailed information will be made available in this Journal.

DANGER TO HUMAN HEALTH.

Undulant fever in man may be caused by the same organism which causes brucellosis in cattle. The disease in man may be contracted from the consumption of milk from cows harbouring the infection in their udders or by contact with infected cattle at the time of abortion or calving. Infections of the latter type are occupational, occurring most frequently amongst veterinarians and dairy farmers who may be required to assist at a difficult calving or in the removal of a retained afterbirth. Cases occurring in cities are almost invariably associated with the consumption of infected milk. Although a very small proportion of persons who are exposed to infection actually develop symptoms of undulant fever the severity of the condition may be such that precautions should be taken for its prevention. Strict antiseptic precautions should always be taken during the handling and treatment of infected animals. Boiling or efficient pasteurisation will render milk safe for human consumption.

The Monsoonal North of Western Australia.

K. M. Durack.

SECTION I.—A survey of the environment and its relation to comparable climatic types.
SECTION II.—The open range, its problems and improvement.
SECTION III.—The Carlton Reach Experimental Area: Findings 1942 to 1945.

SECTION I.—CLIMATE.

A certain amount is known about the geography of the Kimberleys; sufficient possibly, to form a working basis for development if aspects of topography, geological structure, soil characteristics and flora were the only concern of geographical understanding. However, of equal if not greater importance is the nature of the climate, which is in itself a vital consideration in determining the trend of rural development. What confusion exists as regards the potential value of the northern section of our continent, largely hinges on an inadequate or sometimes misleading interpretation of the climate.

The area under review may be classed as having a tropical, monsoonal climate of light rainfall. In monsoonal lands the influence of moisture laden winds from the ocean flowing inland towards a region of low pressure, caused by rising air above a greatly heated land mass, provides a markedly seasonal rainfall with annual precipitations varying from as much as 500 inches in the region of coastal mountains to less than 5 inches for inland centres.

The suitability of the country for white settlement is a perennial question for debate. Outside opinion on the whole seems satisfied that the climate offers a serious challenge to the prospects of settlement owing to its unattractive and likely unhealthy nature.

It is interesting to note that practically all residents of the area would not agree with such claims. Though conceding the point that conditions are trying for a certain period of the year most would contend that on the contrary the climate offers a particularly urgent and unreasoning attraction. Besides, they would be quick to discard the suggestion that the country is unhealthy. Nevertheless, a holiday south is looked forward to, not so much as an escape from the rigour of the climate which after a period of mental adjustment hardly enters the consciousness of a northern resident, but as a means of escaping for a time the far more serious rigour of an isolated existence, often quite devoid of all the amenities of civilisation, which man has come to regard as so important.

It is very likely a fact, that man is not capable of exerting his maximum output of muscular energy during six months of the northern year. It must be remembered, however, that we are living in a mechanised age where it is seldom necessary for humans to work their bodies at full pressure for more than very short intervals. What disability there may be present in this respect, which applies to animals as well as man should not hamper efficient development in the modern sense.

Straightout sickness among the white population is a rare occurrence. The area is quite free from the many serious tropical diseases and malaria need hardly be considered. The suggested unhealthy nature of the climate if such has any foundation must therefore be due to subtler influences than infection.

Presumably our North is considered unhealthy because of a rather false comparison with the equatorial regions of the world which have perhaps rightly been described as "regions of debilitation." Here owing to the absence of seasonal

change, in an area which is continually fairly hot and humid, it has been found that the white man experiences great difficulty in recuperating from a state of ill health which may have been brought about by any cause—accident, unsatisfactory diet or infection. In order to regain full health and vigour a change of climate is more or less essential. On the other hand under light rainfall monsoonal conditions there should be sufficient seasonal change within each year to allow for the continued healthy existence of white settlers. What evidence there is from those already resident in the North supports this claim.

Strickly speaking from a Geographer's point of view we are dealing with a transitional climatic type—transitional between what is classed "tropical savanna" and "low latitude steppe." It is of importance to understand this fact and so realise that it is rather easy to approach any question of development with either an optimistic or pessimistic bias, depending upon whether the country is classified as belonging wholly to the former or wholly to the latter category. While we still have to deal with unknown factors there is always likely to be contention between two factions each of which is capable of proving with figures, no less than words, the serious disabilities on the one hand or the very great potentialities on the other. The only hope of reaching a final, truthful interpretation lies in research directed towards accurate local understanding and correlation on a world basis.

The following brief account of four comparable climatic regions is included in the hope that it may be a small but useful contribution to a study which in the writer's opinion is of vital importance in relation to any policy of development in North Australia.

1. INDIA.

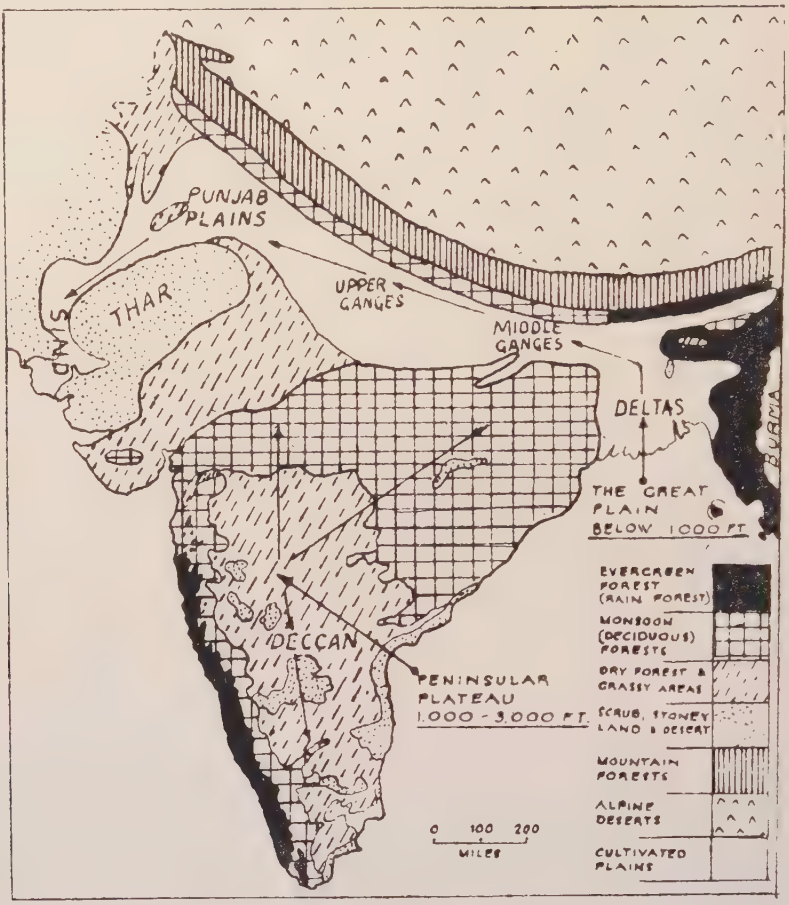
Practically the whole of India is classed by geographers as a "tropical monsoonal" country, yet strangely enough nowhere within its boundaries do we find any extensive areas of true grass land. Even the areas of low rainfall which would superficially appear directly comparable with our northern grasslands carry a low, open thorn forest vegetation with grass occupying a subsidiary part in the flora. To quote from L. D. Stamp:—

> The natural vegetation of India is essentially forest and even the desert tracts are really very dry types of forest. Patches of grass land occur interrupting the monsoon forests on the hills and much of the open thorn forest has a carpet of grass but otherwise grassland is not characteristic of India.

For thousands of years India has been essentially an agricultural region. The general trend of modern endeavour still leads to a system of agricultural land use.

Few people realise the importance and scope of irrigation works in India, especially throughout the great northern plain which extends for more than 2,000 miles across the northern section of the sub-continent. In the Punjab alone, 13 million acres are irrigated. This is but a small portion of the total irrigated area which amounts to more than 63 million acres, or something like a sixth of the whole cultivated area.

Recently large engineering works in the form of canals and dams have been undertaken which yearly bring fresh areas within the irrigation network. Under the Lloyd Barrage scheme of the Indus River in the Sind, nearly 7½ million acres are to be irrigated. As someone has pointed out, India adds an Egypt to her land every year and no one takes any notice.



The natural vegetation of India is essentially forest and even the desert tracts are really very dry types of forest. Patches of grassland occur interrupting the monsoon forests on the hills and much of the open thorn forest has a carpet of grass but otherwise grassland is not characteristic of India.

L. Dudley Stamp. "Asia."

In relation to our own irrigation project which pales beside such enterprise India may be looked upon as a store house of agricultural knowledge in fields which could possibly concern us vitally. A list of their main crops might not be out of place.

Food.	Oil.	Fibre.	Spices, etc.
Rice	Linseed	Cotton	Chillies
Wheat	Sesamum	Jute	Pepper
Barley	Rape and mustard	Hemp	Ginger
Millet	Ground Nuts	Kapok	Nutmegs
Maize	Coconut		Cloves
Gram	Castor		Opium
Sugar			Indigo
			Coffee
			Tea
			Tobacco

Besides, fruits of practically every description, especially sub-tropical and tropical varieties.

2. SOUTH AMERICA.

South America possesses two areas which are comparable with monsoonal North Australia:—

(a) the Llanos of Venezuela and Colombia.

(b) the North Eastern section of Brazil.

(a) *The Llanos.*—The Llanos or low lands of the Orinoco River possess an almost unparalleled grassland area covering 200,000 sq. miles. It lies within a tropical environment having a more than moderate rainfall—40-80 inches. The area is essentually a vast grass covered plain which suggests the nature of the climate—heavy summer rains and absolute winter drought. The country is most interesting in that it presents a picture of an environment that many would wish upon our monsoonal North, simply a bountiful seasonal rainfall and on the other hand an environment that many seem to imagine our North really does possess in the form of general climatic disabilities.

Economically, industry in the Llanos, which is at present almost wholly restricted to the rearing of cattle and horses, has lagged behind other parts of South America. After a study of the area it is fairly easy to imagine why. Stock suffer severely from plagues and pests, the likelihood of flood together with the normal hazard of swamp and bog renders the area almost unmanageable and inaccessible in the wet season. Grasses, reacting to the bountiful rain rapidly reach a state of development too coarse and unpalatable for efficient utilisation by stock and once dry may be considered even less useful. The climate and low-lying nature of the country provides ideal conditions for malaria and other fevers which are common so that it appears an unsatisfactory habitat for man. To such factors must be added the country's stormy political heritage. Despite such obvious disabilities the area apparently carries a fairly large population, at least when compared with Australian standards.

Under improved conditions the grasses La India and Yaragua are recognised to be of great value and reference has been made to the use of alfalfa in an effort to overcome the severe nutritional stress of the annual drought. If it is correct that the Llanos can grow alfalfa satisfactorily a study of its reaction in such comparable and likely more rigorous environment could very possibly provide us with considerable enlightenment.

(b) *North Eastern Brazil.*—In North Eastern Brazil there is an area which may be looked upon as an island, within an otherwise almost wholly humid tropical region characterised by uncertainty of rainfall and partial aridity, a land of violent storms, floods and droughts to which Brazilians have given the name "Job of the North." In considering this environment it must be remembered that when not suffering from drought the area receives what could be almost looked upon as abundant rain, so that between periods of denuding desiccation and torrential downpours, presenting ideal conditions for erosion, this section of Brazil is sorely tried.

In times of drought the populace is forced to evacuate the stricken region. In one instance forty-five thousand people left the "Sertao" in the State of Ceara. To overcome water shortage the Brazilian Government has instituted a programme of water conservation in the form of reservoirs, which seem to be similar to the famous "tanks" of India.

For the above reasons and also because of a peculiar climatic trick which causes the rainy season to occur in autumn rather than summer, so that no rain falls during the hottest period of the year, the area is not directly comparable with our North, but does provide a most interesting field for fruitful comparative study.

The country may be divided into several distinct regions predetermining any programme of land use. Firstly, the comparatively well watered coast lands of limited extend—the "Matta," which is characterised by agricultural enterprise. Secondly, as we proceed inland the "Caatinga" possessing a rather typical arid type of vegetation within which cacti are prominent and thirdly the "Sertao," a land of brush wood and grasses extending to the upland regions of greater rainfall reliability. Here we find the greatest development of pastoral enterprise. Despite obvious shortcomings such pastoral activities are extensive in scope. It is estimated that there are four million cattle of the Zebu type and over 3,000,000 goats in Brazil's north-eastern States (excluding Bahia).

The following is an interesting quotation from a writer referring to this area:—

> Cattle rearing is organised on large scale lines on great estates, each of which is largely self sufficing as to food supplies in ordinary times. Attached to these estates are small colonies of permanent settlers called "Moradores," whose business it is to cultivate the food crops for the whole patriarchal community . . . The cattle roam at large and the small areas under crops are fenced in.

(*Vide* Land Utilisation Prospective, in the "Kimberley Project," by L. J. H. Teakle. *Journal Dept. Agric.,* Dec., 1944.)

Together with the main ranching undertakings there are three subsidiary industries.

(1) Cotton culture, in regard to which it is said that the annual type is only grown in favoured districts, whereas a drought resistant tree variety becomes prominent in less favoured areas.

(2) Production of Carnaúba wax from the Carnaúba Palm, a drought resistant tree growing wild over extensive areas of the Sertaos and Caatingas. The wax is obtained from young leaves. Fruit and pith provide food, the stem timber and leaves are used for roofing purposes.

(3) Rubber production. Two types of rubber producing plants are native to the area, viz., (a) the Manicoba plant, *Manihot glaviovii,* producing what is known as Ceará Rubber, and (b) the Mangabeira Tree, *Hancornia speciosa.*

Once again it is of interest to point out that there is a body of opinion which when dealing with the subject of of our Northern environment lays much stress on:—

(a) The unreliability of the rainfall and possible drought.

(b) The likelihood of floods.

(c) The damaging effect of torrential downpours.

(d) The imagined disability of great heat and evaporation in summer as a factor in limiting the growth of plants.

It would appear that their arguments would fit the outlook of north-eastern Brazil much more closely than that of our Northern Area. This does not mean that we are without some of these disabilities or that we should in any way pass them off as unimportant, but it does mean that in approaching the subject it is necessary to keep all aspects in perspective. It is here claimed that in relation to at least monsoonal North-West Australia they are not so important as some would suggest.

3. AFRICA.

One might suppose that large sections of Africa would be comparable in more than a superficial way. However, after interpolating the factors climate, vegetation, topography, latitude and rainfall, our search is narrowed down to an area which by happy coincidence is almost the direct mirror image of Northern and particularly North-Western Australia, namely the Western Sudan.

1. Desert 2. Semi-desert with small scanty bush. 3. Dry grassland with acacia. 4. Savanna. 5. Park savanna. 6. Rain forest of Guinea, Congo and Madagascar. 7. Mediterranean and cape forest and thicket, East African highland forest 8. High platcau grasslands of Abyssinia. 9. High plateau grasslands of Equatorial East Africa and of Madagascar. 10. High Veld. 11. Palm belt of Natal. 12. Marsh. 13. Mangrove.

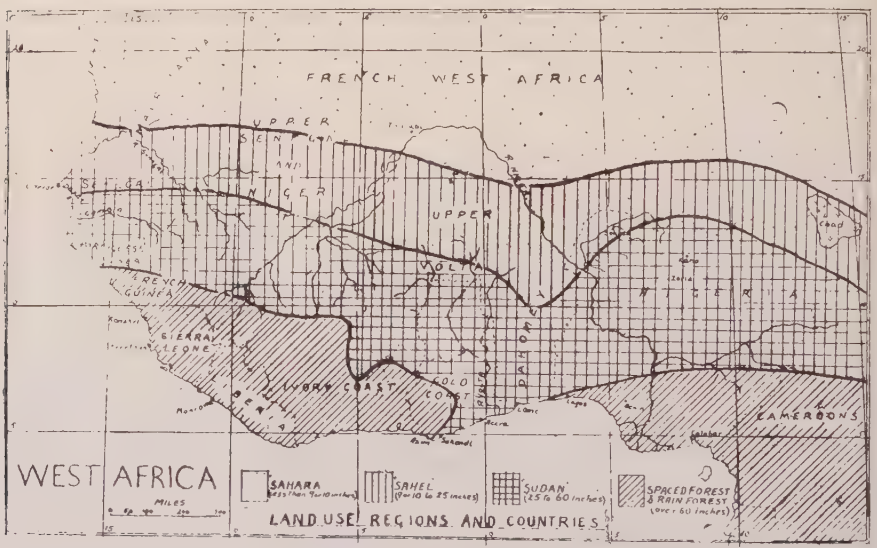
The French recognise several land use regions within their large colonial territory of French West Africa. Three regions of most significance to us are:—

(1) The Sahara, a region almost wholly unmitigated desert with a fringe of semi desert on its southern border.

(2) The Sahel, an area of dry Savanna merging into the Sahara region on its northern boundary. Over the whole area rainfall does not exceed 25 ins.

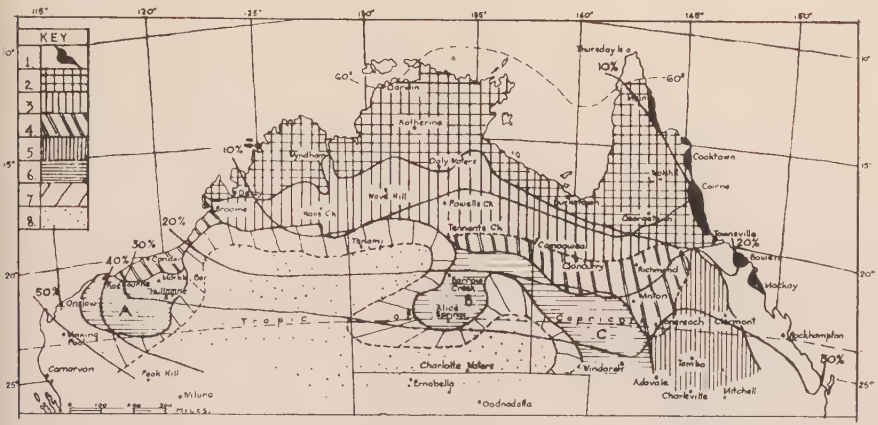
(3) The Sudan, tall grass wooded savanna with a rainfall of between 25 and 60 ins.

The above land use regions together with the area of spaced forest and equatorial forest, 60-160 ins. rainfall, have been charted on a map of West Africa and their boundaries extended outside French territory. Further, comparable regions have been indicated on a map of Northern Australia.



It is interesting to note that apparently the greatest agricultural development in French West Africa has taken place within the Sahel and about the low rainfall boundary of the Sudan. Soil types (refer soil map) and the peculiar requirements of the exceedingly important crops, ground nuts and millet may be responsible. It has been stated that up to recent years ground nuts contributed more than half of the outgoing commerce of French West Africa.

When we consider the soils and topography of North Australia (refer map) it is reasonable to suppose that as appears to be the case in French West Africa, large scale developments in monsoonal North Australia will follow the boundary between the Australian counterpart of the Sahel and Sudan, with more extensive use being made of the former, if only as a controlled pastoral undertaking.



1. Rain Forest, humid 10-12 months effective rainfall. 2. Sudan (open forest, savanna woodland ranges), semi-humid 4-6 months effective rainfall, 25in.-60in. summer seasonal rains. 3 and 4. Sahel (savanna woodland and savanna principally), sub-humid 2-4 months effective rainfall [less in the DeGrey, Anna Plains and Sturt Creek areas]—(3) North Sahel, not more than 15 per cent. of rainfall during winter months, fairly reliable rainfall; (4) South Sahel, above 15 per cent. of rainfall during winter months, unreliable rainfall. 5. Queensland, Central Western (open forest, acacia scrub, savannah), semi-humid 4-8 months effective rainfall, effective inter-seasonal rains, unreliable rainfall. 6. (a) Ashburton, Fortescue (dry steppe and ranges); (b) Alice Springs (mulga, salt-bush, spinifex, sandhills, parkland and ranges); (c) Queensland Far Western (grassland, open forest, "channel country," mulga, spinifex sandhills and ranges); semi-arid, low rainfall, very unreliable, effective inter-seasonal rains. 7. and 8. Sahara (7) Desert Margins; (8) Desert; arid.

Note.—Lines indicate the percentages of the precipitation falling in the six "winter" months April to September.

This map has been arranged for comparison with a West African interpretation of land use regions.

The Australian Sudan-Sahel boundary in accord with the French definition follows the 25in. isohyet. Such line could be expected to have true significance as a critical land use boundary for North Australia in that agriculture restricted to short season monsoonal crops should be just possible, within suitable areas, where the rainfall exceeds 25ins.

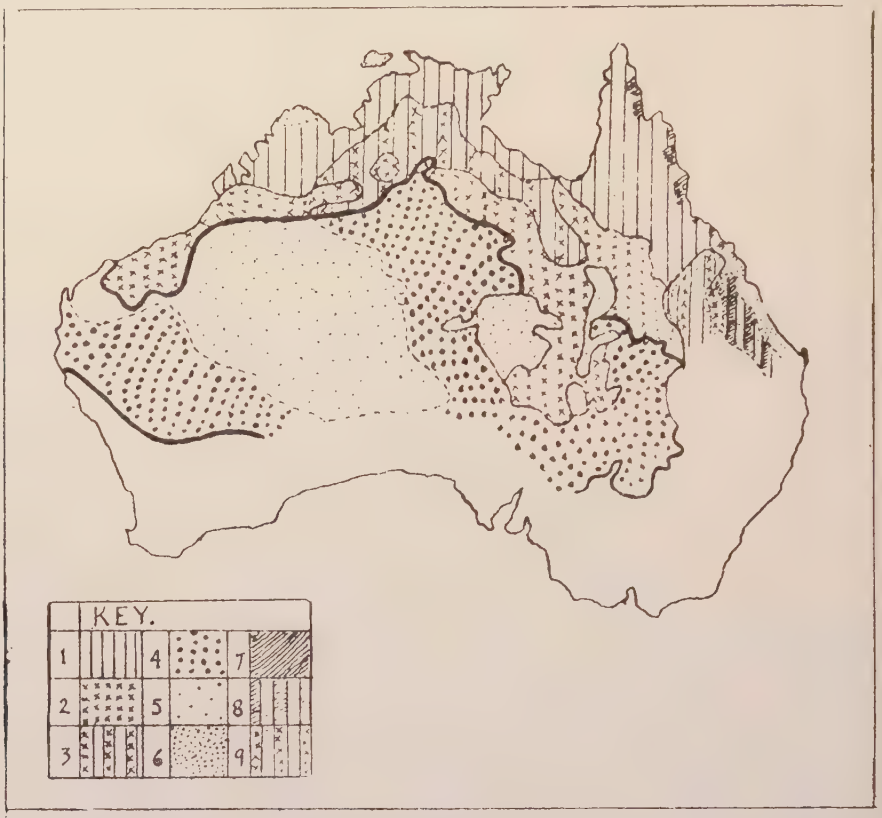
For Australia the mapping of a Sahel-Sahara boundary presents certain complications owing to the intrusion of areas which, mainly because of differences in the rainfall regime, cannot be considered as part of the Sahel.

These areas of intrusion into somewhat higher latitudes, receive a considerable percentage of their rainfall during winter months. When not suffering from drought they possess a grazing value in advance of the more northern pastoral areas in the Sahel. An adequate understanding of the factors involved is of vital importance to the future development of the Fitzroy, Ord, Victoria River and Barkly Tableland districts.

In Queensland, particularly, the Sahel, when considered as a whole, tends to lose significance as an area of strictly summer seasonal rain. At Cloncurry for example June has received effective rainfall as frequently as March. It therefore seems advisable to introduce a distinction between a Northern "True" Sahel and a Southern Sahel which receives effective winter rains in a number of years. The far eastern boundary of the latter subdivision has been made to correspond with the isochrone of four months seasonal duration, and the southern boundary in Western Australia follows the limits of the spinifex plain country (brown soils of light texture).

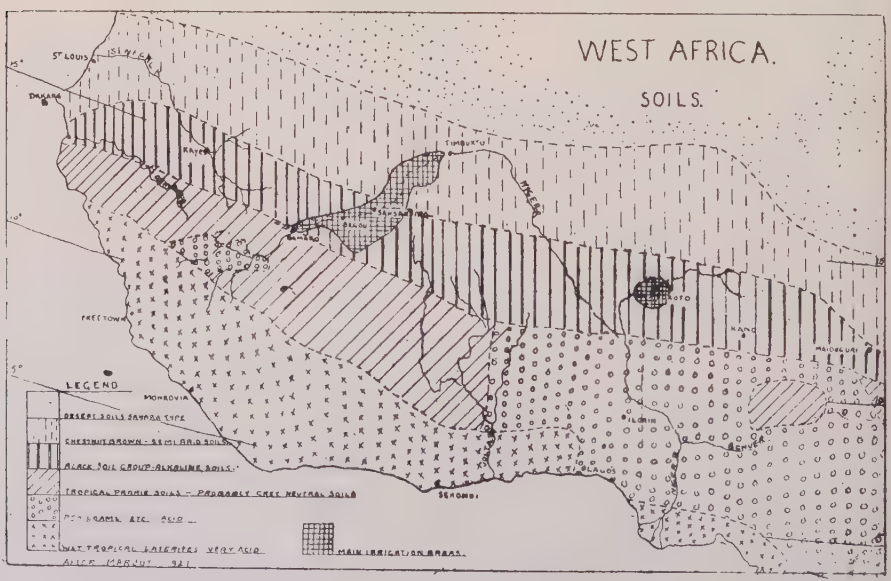
A study of the pastoral situation in the Queensland Central Western District, characterised by a comparatively equable distribution of a low rainfall throughout most of the year, has direct bearing on the problems of the Sahel so typically represented in the Kimberleys.

In compiling the map, use has been made of the work of Elizabeth F. Lawrence, C. A. Gardner, J. A. Prescott, A. McTaggart, A. G. Lowndes and H. H. Finlayson.



1. Park savanna. 2. Savanna. Grassland with few trees. 3. Mixed park savanna and savanna. 4. Dry grassland and acacia mulga. 5. Desert grasses. 6. Spaced forest. 7. Dense forest. 8. Mixed spaced and dense forest. 9. Mixed spaced forest and grassland. The thick line separates the realm of the eucalypts from that of acacias which prefer dry country.

Map courtesy Dr. J. Gentilly.



In this map the distribution of soils is indicated:—1. Tablelands and ranges. 2. Heavy textured brown soils carrying open grasslands. 3. Black earths, including modified black soils carrying brigalow scrubs. 4. Soils of the desert and semi-desert other than sandhill country. 5. Desert sandhills carrying Triodia. 6 Red soils, including the red loams of the Atherton Tableland. 7. Low lying coastal plains with heavy soils subject to flooding. 8. Sandy and stony soils, including brown soils carrying low tree savannas and inland and coastal podsols associated with savanna woodlands and heaths.

(After Prescott.)

Reference to a world rainfall variability map shows that our monsoonal North and West Africa are fairly comparable for this vital aspect. Though West Africa, as Prescott has clearly demonstrated, has a more reliable rainfall, it must be recognised that monsoonal North-West Australia does not suffer any great disability in this respect. The area may be classed as having an assured rainfall quite adequate for pastoral needs with careful management. Droughts are not a factor to be reckoned with. (Refer experimental findings.)

The French have commenced to develop a large irrigation scheme which will eventually cover nearly eight million acres in the middle Niger basin between Bamako and Timbuctoo, thus controlling to a large extent the flooding which occurs annually below Segou where the river slowly works its way through an intricate network of channels and lakes eighty miles wide, in some years inundating an area of thirty thousand square miles.

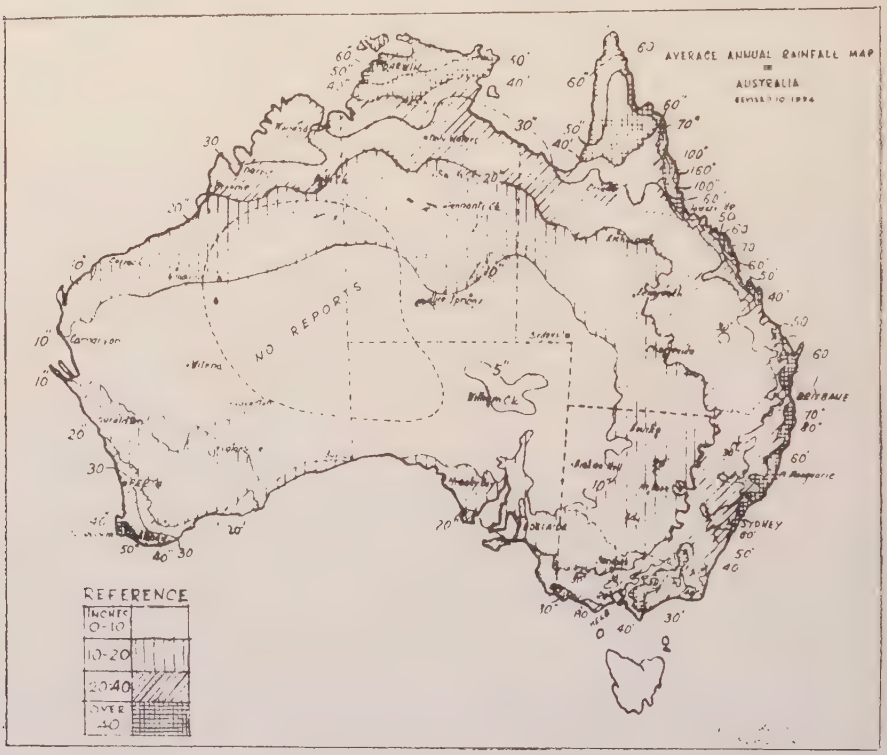
Up to the present time cotton culture has occupied almost exclusive attention. Fitzgerald points out that prior to French penetration the area was self supporting under a system of multi-culture but latterly owing to an insistent emphasis on the production of cotton tending towards an unsatisfactory system of mono-culture, large quantities of rice and other foodstuffs have to be imported annually for local consumption.

Pastoral industry in the Sudan appears very primitive and fades in significance besides what is essentially agricultural occupation. To quote from Fitzgerald, "when estimating the potential resources of the Western Sudan one should not overlook the undoubted future that is offered to a ranching industry of vast dimensions, comparable that is to say, with the great stock industry of the Argentine Pampas and the Australian Downs."

When concern is expressed about the encroaching Sahara, and an apparent process of gradual desiccation of the grass lands, one wonders whether West Africa, approaching pastoral expansion, might learn from us the dangers of vast uncontrolled ranching industries in return for what we could well learn from her in the form of agricultural technique.

Before leaving the West African scene it may be of interest to note that the Shea tree, *Butyro-spermum Parkii,* with its important product, Shea butter, might well find a home in Kimberley.

Other tropical areas in Africa, particularly the eastern states south of the Equator, although in no way directly comparable, provide an interesting field for study, especially in relation to grass land management and animal husbandry under improved conditions.



As far as the writer knows there are no areas comparable to our North using irrigation for pasture development, so that a knowledge of grassland development under naturally humid tropical conditions is the next best field of study when considering this likely important phase of our northern development.

It is comforting to learn that the results of our own experimental work, small as they may be, closely follow the general conception of profitable and healthy land use in a humid tropic environment. It seems that as far as pastures are concerned their problems are our problems but that luckily we being in a position to regulate precisely the all important factor, water, as well as possessing for six months a comparatively dry atmosphere, should be in a much better position to overcome those problems. The mere fact that we should be able to grow lucerne satisfactorily simplifies the whole outlook. (Refer experimental findings.)

4. AUSTRALIA.

Perhaps one of the most significant experimental results of the last three years has been the indication that the research findings of the sub-tropical parts of Australia, as regards grassland management and improvement, will be fairly applicable within our thoroughly tropical monsoonal environment. In fact it seems that we can even go as far as to say that under irrigated conditions our prevailing northern environment, for plant growth more closely approaches that of Lawes in Southern Queensland than that of Townsville and like areas in the North.

This means that not only may a study of Queensland sub-tropical rural conditions help us considerably, but also, that we may call on the knowledge of the sub-tropical southern States of the U.S.A. and the Argentine.

It must be stressed, however, that these humid sub-tropical regions only become comparable when we accept the possibility of overcoming the prevailing sub-humid conditions of our North through irrigation.

Anyone familiar with Mediterranean climatic conditions (generally recognised as the nearest possible approach to an ideal living environment) would find it somewhat difficult to adjust his outlook to tropical monsoonal conditions. It may therefore be useful to list some important features which the South West and far North West of Australia have in common.

(1) Each is subject to a rather low rainfall, ranging from about 40 to 10 inches, so that there is in the Mediterranean area and is likely to be in the monsoonal area, a characteristic zoning of land use from the coast inland.

(2) The reliability of the rainfall is roughly comparable in each case. In as much as rainfall reliability figures provide a useful index for the success of agriculture, it must be pointed out that although agriculture may be considered safe within the Southern area where rainfalls are considerably less than 20 inches, for the northern area agriculture could, it seems, only be contemplated where the rainfall exceeds 25 inches.

(3) Both areas have a strictly seasonal rainfall as opposed to the inter-seasonal rain of most subtropical regions and the more or less continual rain of Equatorial regions. The seasonal rainy season implies an extensive period of drought. Each carries a natural vegetation peculiarly adapted to withstand such period of stress.

Because of such common exigencies of climate irrigation if possible should be of great importance to the economic development of both areas.

We may likewise list some important differences:—

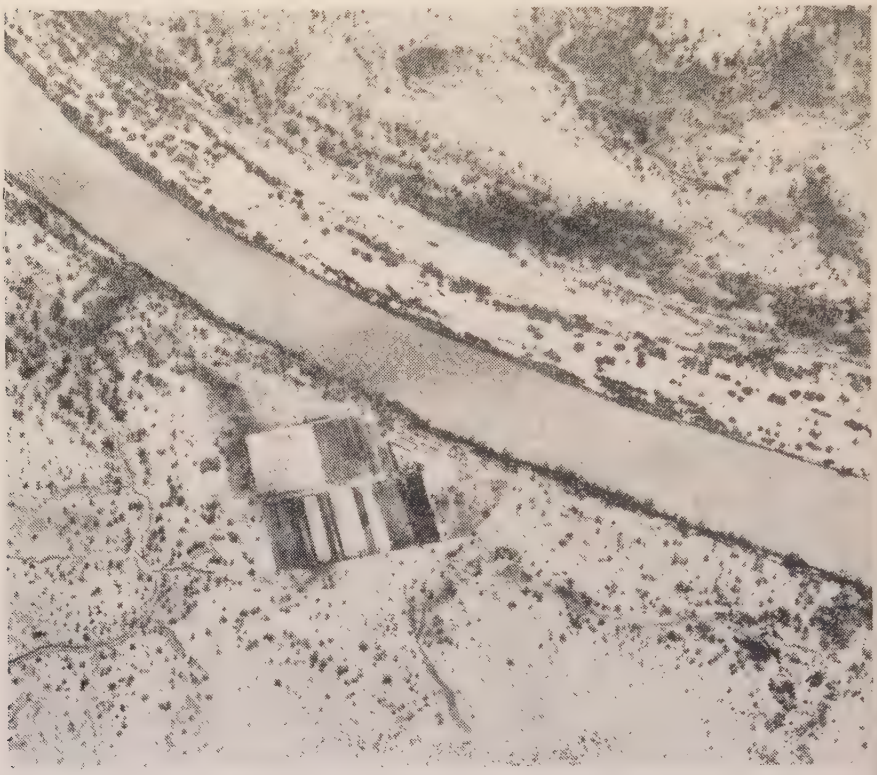
(1) The South West receives the bulk of its rain in winter. The monsoonal North West receives its rainfall in summer.

(2) The length of the wet season is shorter for the North. The ideal growing conditions present during the monsoonal wet season could be expected to narrow down any relative disability in this respect.

(3) The rainfall per wet day is considerably greater under northern conditions. In a summer rainfall area this can hardly be considered undesirable, as light showers unless immediately following substantial falls would be of little value. Besides, monsoonal crops seem well adapted to take full advantage of isolated heavy bouts of rain.

(4) A winter rainfall does not favour the growth of grass so that until extensive research somewhat overcame this disability of Mediterranean areas they

were pre-eminently agricultural lands. On the other hand summer rains favour abundant development of grass pre-eminently therefore the North is and is likely to remain a pastoral proposition. In its natural state the latter stands as a greater asset than the former.



Aerial photo of Experimental Plots—December, 1944.

SECTION II.—THE OPEN RANGE.

The pastoral industry throughout Australia's light rainfall areas has up to the present conformed to the simple pattern of extensive open range management It has been a system of exploiting the natural grassland and herbage resources of the continent for what they are immediately worth.

The provision of water to make such grazing land fully available has been one greatly important aspect of improvement; considerably more important than the only other recognised essential of improvement, fences and yards for stock control.

This system has been applied throughout the whole continent regardless of the peculiar conditions and needs of widely differing districts. It has almost up to the present worked remarkably well, so much so that it is more or less looked upon as the only feasible method of pastoral exploitation. Now, however, there are obvious signs throughout the entire hinterland that such a policy of land utilisation will not work indefinitely, simply because the natural fodder

resources are not a stable and unchanging asset, but one peculiarly responsive to treatment; which is expressed in a now rather obvious law:—

> Uncontrolled stocking on a sufficient scale to satisfy man's economic demands leads eventually to denudation and final pasture destruction through erosion.

We are at the present entering a new era of land appraisement, in which it is beginning to be realised that Australia's out-back needs classifying into at least three regions. Firstly, marginal stocking areas of lasting difficulty. Secondly, potentially valuable areas which however are subject to drought and so require delicate handling. Thirdly, areas of assured rainfall which should respond through careful management and the application of research to become lasting assets of great national significance.

Stock in Lucerne Pasture—Ord River.

Such like arrangement is the first vital step in recognising that for the future successful continuance of the vast stock raising industry of Australia, the accent needs to be on pasture control as well as stock control.

In the writer's opinion, after nearly ten years of close observation and three years of experiment, monsoonal North Australia falls into the third category. With good sense in stocking and ordered research for pasture and stock improvement there seems no reason why it should not become one of the most prosperous and stable cattle rearing centres of Australia. With the provision of irrigation it should rank in capabilities if not in extent among the greatest beef producing centres of the world, quite apart from any subsidiary industries which irrigation would make possible.

The realisation of this goal will largely depend on the extent to which we are capable of appreciating fully the controllable limitations rather than the immediate productive value of the land. It would therefore appear important to review very briefly certain problems which confront the pastoral industry as it stands at

the moment, and also point out certain observed facts with regard to the effects of roughly sixty years of open range grazing management on the natural grasslands of the country.

At the end of the wet season in Kimberley and the adjoining areas of the Territory there is what could be casually looked upon as an over abundance of feed. Much of it will, however, be coarse and unpalatable and probably by August all pasture will be below maintenance in terms of protein, phosphate and vitamin content. (Research in similar latitudes indicates that by far the major problem confronting an animal relying solely on natural grass to fulfil its needs, is that of protein deficiency.)

Towards the end of the dry season cattle are of necessity concentrated around permanent waters. Feed in the vicinity is likely to become extremely scarce, so that they have not only to cope with nutritional shortcomings but also straight out starvation.

The first rains can only be expected to aggravate the situation by further leaching what feed is available and by imposing on stock a severe muscular strain through their often futile efforts at "storm chasing."

Unless immediate seasonal conditions are extremely favourable, the bulk of the herd remains concentrated along river frontages or around bores. Feed has little chance of coming away in the face of such stocking; a state of affairs which is serious in October, may well be prolonged until the end of December. It is only after December that the expected incidence of the rainfall becomes much more favourable and full relief is certain.

Under these conditions there is a tendency for the effective season to become shorter and shorter as the years progress and frontages deteriorate until claimed by a sparse weed flora which is not sufficient to prevent final desolation through erosion.

The situation varies from year to year and the intensity of the trouble will vary also with the type of country concerned. The fact, however, that we are confronted with a man-made problem of serious and ever increasing proportions cannot be denied.

It must be recognised that improvement does not entirely depend on the expedient of providing water as a means of bringing fresh country into use or by the provision of fencing and yards to facilitate the handling of stock, as there is no limit to the amount of country that can be eventually ruined if we do not know exactly the laws governing the existence of the very life blood of the industry—the natural grassland.

As a result of the existing policy of management there is evidence to show that a process of grassland deterioration has occurred; continuance of such a policy must eventually lead to the time when it will no longer be possible to rear stock on a profitable basis.

Grassland research is urgently needed to determine the limits within which pastures may be maintained indefinitely at an appropriate level of productivity, and also to investigate thoroughly the feasibility of improving that standard of productivity with due regard to the essential nutritional needs of the grazing animal.

At the moment we can but say that all evidence, observational and experimental, which is available points to the fact that such research would be extremely fruitful; that there is a definite possibility of vastly improving the present carrying capacity of the district.

The attached chart is submitted as a contribution towards the study of grassland associations in relation to stocking practice. It may be looked upon as a survey of pasture succession, progressive or retrogressive, operative under large scale grazing in Kimberley with particular reference to the Ivanhoe area.

The succession ranges from the highest expression of grassland under the natural environment, namely the likely state of the grassland in the pre-stocking era, to bare ground which has become a feature of frontage areas in the immediate vicinity of watering places. The process may be regarded as a reversible one dependent on fluctuations in stocking or particular conditions of stock management. The whole indicated system hinges, as it were, about the region classified as the lowest expression of grassland consisting of annual grasses of a very ephemeral type. It may be divided into two distinct phases:—

(i) The herbage phase—indicating marginal grazing conditions.

(ii) The grassland phase—indicating safe grazing conditions.

The estimated usefulness of the varying associations has been indicated. It will be noted that the higher expressions of grassland do not necessarily mean a better quality pasture, this is particularly true for red soil areas. However, it appears that the climax grass association of black soil may be recognised as a most satisfactory pasture, namely, the blue, Mitchell and Flinders grass country of much renown. It may be said that only island areas now retain this particularly useful combination of grass types.

SECTION III.—CARLTON REACH EXPERIMENTAL AREA, EAST KIMBERLEY.

PRINCIPAL FINDINGS, EXPERIMENTAL AND OBSERVATIONAL, 1942 TO 1945.

PART I.—IRRIGATED PASTURE—PERMANENT AND SEMI-PERMANENT.

1.—The prospects of obtaining a permanent highly productive pasture are good. Permanent being in the sense of a five or six year ley. Such statement at the moment, is wholly dependent on the fact that lucerne under certain conditions will persist as a mixture with grass. Sufficient time has not yet elapsed for definite conclusions to be reached, but we do know enough to assure excellent results, well into the third grazing year, from a paspalum/lucerne or rhodes/lucerne pasture. A uniform carrying capacity of two beasts to the acre could be expected.

2.—It can be stated almost categorically that irrigated pasture requires a suitable mixture of grass and legume for continued satisfactory production.

3.—This does not mean that in the final analysis pure grass swards would have no place in a mixed farming economy. With due regard to the problems involved, straight out grass pasture, irrigated and looked upon as a semi-permanent ley of one or two years duration, should, owing to comparative ease of establishment, find ample scope for recognition as a profitable undertaking.

4.—Simply considered however, it must be recognised that returns from a pure grass sward will be remarkably low after a very few months. Lack of available nitrogen here certainly plays a major role.

Pasture Components.

5.—Lucerne is likely to be of great importance in any developmental project concerned with irrigation. Certain problems have arisen with regard to its healthy persistence, especially where it is considered as a pure grazing stand. Evidence indicates that we may reasonably hope for satisfactory control of such problems through relatively simple management practice.

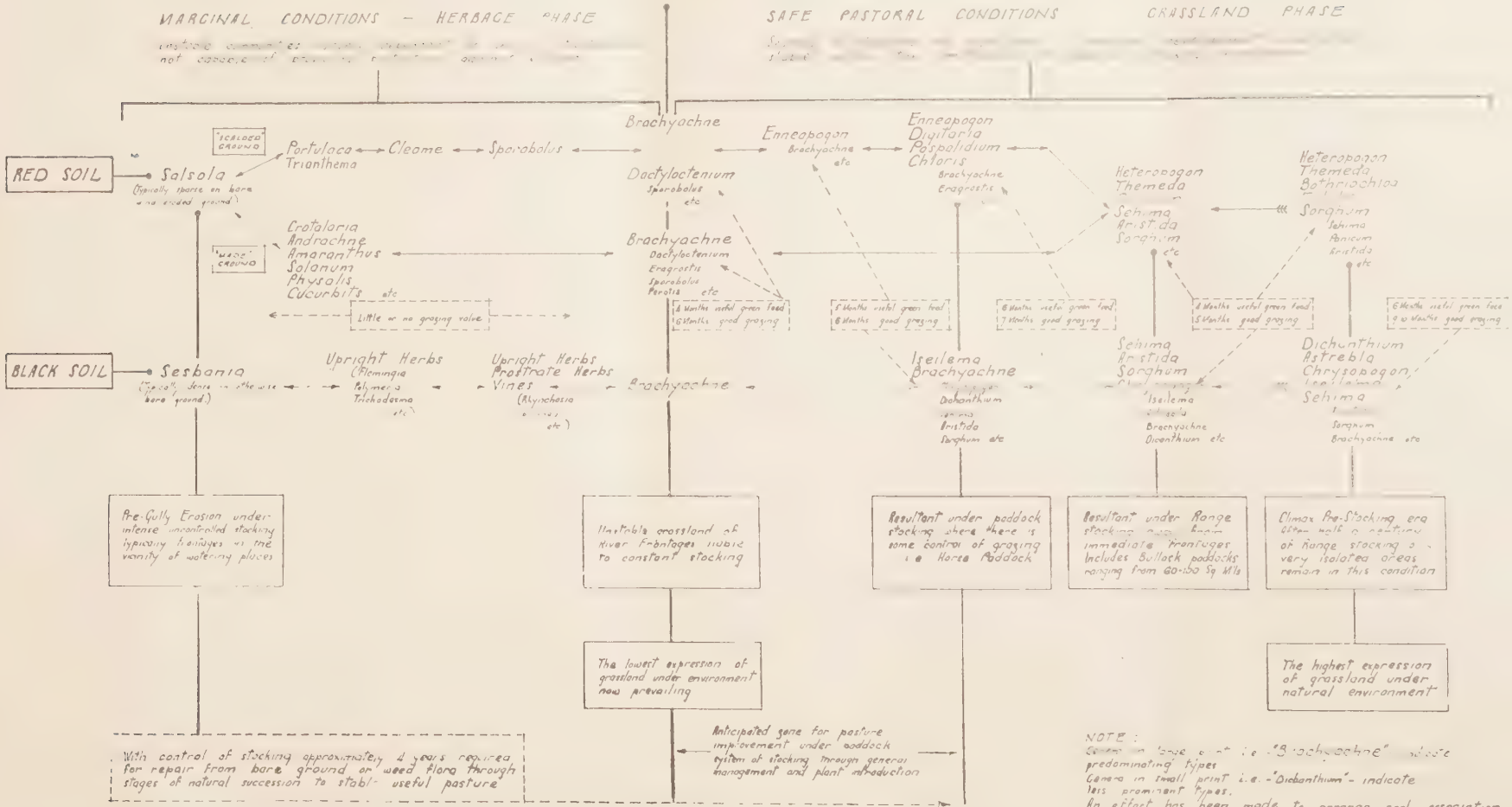
6.—Tropical grasses in general when functioning as perennials, tend to lie dormant during the winter months. Further, grasses with a low water requirement will not tolerate a continually moist environment. Thus, the grass fraction of permanent pasture (which for the time being at least, must be looked upon as a grass-lucerne mixture) is restricted to types which, firstly, other factors being equal, are capable of a long productive period within each season; secondly, can stand permanently moist conditions, and thirdly, by reason of their growth habit will allow lucerne ample scope for satisfactory development. (Grasses which tend to develop large tussocks are not suitable.)

The Ord River at the New Experimental Site.

7.—Three examples that fulfil the above requirements are Paspalum, Para grass and Rhodes grass. The latter being exceedingly aggressive in its early growth, can only be considered as a candidate when introduced sparingly to a lucerne stand after it has become established. In each case the essential process is the same, with the grass fraction coming into prominence only after lucerne has made considerable headway without competition. Subsequent management must be directed towards retaining good conditions for the growth of lucerne. Rather frequent and thorough renovation becomes important, as also heavy waterings at long intervals rather than light waterings at short intervals.

8.—In the case of semi-permanent pasture, as defined earlier, grasses which develop rapidly come into prominence. Among many of potential value, Rhodes and Guinea grass are likely to be of outstanding importance.

CHART OF PASTURE SUCCESSION PROGRESSIVE OR RETROGRESSIVE UNDER EXTENSIVE GRAZING CONDITIONS IN KIMBERLEY WITH PARTICULAR REFERENCE TO THE IVANHOE AREA



PASTURE SUCCESSION CHART.

	Common Names:
Salsola	Roly poly.
Sesbania	Pea bush.
Portulaca	Pig weed.
Sporobolus	Fairy grass.
Brachyachne	Native couch.
Dactyloctenium	Button grass.
Eragrostis	Love grass.
Perotis	Comet grass.
Enneapogon	Nigger head.
Chloris	Windmill grass
Iseilema	Flinders grass.
Chrysopogon	Turnover grass.
Dichanthium	Blue grass.
Sehima	White grass.
Aristida	Feather top or wind grass.
Sorghum	Sugar grass.
Heteropogon	Bunch spear grass.
Themeda	Kangaroo grass.
Astrebla	Mitchell grass.
Bothriochloa	Blue grass.
Eulalia	Brown top.

9. The need for legume admixture in this type of pasture is important. A number of essentially tropical legumes have been grown successfully as pure stands. Work in this field has not been sufficient to justify any statements as to whether promising types could cope with the competition of a vigorous grass stand. *Phaseolus lathyroides*, an annual and *Stylosanthes guianensis*, a perennial, may prove very useful. Besides, pigeon pea, a perennial peanut, and even cow pea have some potential value.

Irrigation Technique.

10. The Border System, Level Check or Contour Check methods of irrigation are necessary for pasture layout. Furrow irrigation of pastures is impracticable because of:—

(i) The deep unchanging profile of the soil.

(ii) The essentially humus-less nature of such tropical soils, which compact with watering and trampling to a limiting degree.

11. In experiments to date, the Border System has been almost exclusively used. Borders six chains long and 22 feet wide have proved quite satisfactory.

Water Requirements of Pasture.

12. Experience so far indicates that we may expect the irrigation season to last from Mid-April to Mid-December. Although further information is necessary, it seems that for optimum and lasting returns watering will be necessary at three weekly intervals throughout the greater part of the season.

13. No serious work with regard to the water requirements of pastures has been carried out. It is rather obvious that irrigation practice to date has been generally in excess of plant requirements. Now that we have some knowledge of the likely reaction of various plants to the environment, it is possible to attack this question in some detail. It is nevertheless, reasonable to suppose, that other factors being equal, the ratio of water applied to resultant growth is well within economic bounds. General management in the nature of renovation and regulating the recovery period between grazings will be most important factors influencing effective utilisation of irrigations.

PART II.—NATURAL PASTURE.

14. The improvement of natural pasture has been the subject of some experiment and careful observation, as a result of which, although much more work is required before final judgment can be passed, it is possible to suggest as follows:—

Irrigation of Natural Pastures.

15. The concept of extending the growth period of natural pasturage by irrigation must be approached with caution, and as an ameliorative measure, such no doubt costly arrangement, should not be necessary and could be most harmful.

16. It is extremely doubtful whether the natural grass species available would respond to much more moisture than the rainfall already provides. Experience indicates that where at least the river alluvial soil is irrigated, in its natural condition, there is, if such irrigation is carried out as a normal practice, a rapid reversion from grassland to wasteland, carrying immediately all the perennial weeds of the district to the exclusion of grass.

17. Apart from the fact that we have been able to observe, after the first waterings, green feed where normally none would exist, little has been gained to offset a much greater future loss. A problem in fertility also becomes evident which could be as much responsible for pasture failure as the relative moisture toleration of different plant species.

18. The mere fact of watering seems a straightforward and simple procedure, but it sets in motion a complicated mechanism of change. It therefore appears that pasture, when irrigated, is subject to the limitations and requirements of a much altered internal environment and that the premise "more water means more profitable growth" does not necessarily follow.

Sufficiency of the Rainfall.

19. Other factors being reasonable the natural rainfall is always sufficient for the abundant development of natural grass types. This it appears can be taken as axiomatic, and such assertion could well be operative over a much wider belt of country than the Ivanhoe district and its immediate surroundings. It follows, that if grass is not plentiful on areas of recognised grazing potential, it must be due to factors other than the rainfall.

Grazing Potential of Seasonal Pasture.

20. Seasonal pasture is here taken to mean any forage species or combination of species endemic or introduced growing entirely under natural rainfall conditions.

Within the experimental area, observation has shown that rotationally grazed seasonal grass pasture is capable of very high production over an extended period within each growing season, but that even though dealing with the natural rainfall, production is limited by fertility. To make full use of the productive power of suitable grasses and the moisture available, the fertility status of the soil needs to be raised. The introduction of a vigorously growing edible legume could be expected to both expand the possibilities of production and greatly enhance the value of the feed, especially during the dry months. (Unfortunately it is not yet possible to even suggest a likely suitable legume.)

21. The fertility of the soil should be quite adequate however, for the requirements of any extensive grazing concern.

Grasses Suitable for Seasonal Pasture.

22. For the improvement of seasonal pasture the following grasses can be immediately looked upon as worth encouraging:—

A. For so called red soil areas:

i. Buffel grass.
ii. Birdwood grass.
iii. Blue panic grass (*Panicum antidotale*).
iv. Digitaria species.

B. For so called black soil areas:

i. Blue grasses (especially *Diclanthium sericeum*).
ii. Mitchell grasses (especially *Astrebla lappacea*).
iii. Flinders grasses.
iv. Chrysopogon species.

The Prospects of Improving Natural Pasture.

23. Summing up the present outlook for the improvement of natural pastures, it may be said that we can go far towards greatly relieving the annual nutritional stress by simply insuring that pastures can take full advantage of a quite sufficient rainfall. The prospects of further improving the situation through plant introduction and/or plant reinstatement, together with the provision of home grown concentrates, should be agriculturally possible and we might dare to hope economically sound.

24. Comprehensive research in this field directed towards general agronomic aspects should be relatively straightforward and amply justified.

PART III.—FARM CROPS.

25. Efforts in respect to the growing of farm crops have mainly been directed towards ascertaining the nature of the habitat involved and gaining some idea of necessary cultural practices.

Crop Types Under Trial.

26. The crops used for such preliminary investigation have been summer growing types such as grain sorghums, Sudan grass, millet, maize, cow pea, pigeon pea, peanut, bombara ground nut, cotton, rosella and soya bean. With the exception of soya bean all have proved that they are thoroughly suited to the prevailing soil and climatic conditions. Grain sorghums are outstandingly successful. It may be well to note that rice has not been tried. It should be admirably suitable as a crop for "black soil" areas.

The Climate in Relation to Crop Production.

27. When the moisture factor is regarded as a constant, climate is suitable for at least the vigorous vegetative growth of summer growing crops throughout the year. Unless considered as purely forage propositions however, successful yield of the final product (grain, fruit or fibre), will depend on the peculiar conditions prevailing at the time the crop is approaching maturity. Thus maize in the tasseling stage would be seriously effected by the hot dry blasts of October. Again much loss from a number of causes could be expected if cotton was to mature during November or somewhat later. The same would apply to peanuts or sorghum.

28. Generally where crops are to be grown for their end product, seeding time would lie between December and May.

Cropping Under Natural Rainfall Conditions.

29. There is considerable, yet not conclusive evidence to support the contention that the natural rainfall is quite adequate for the healthy development of the more typical short season monsoonal crops. Which means in the final analysis that provided adequate cultural steps are taken, seasonal variability of rainfall, rainfall intensity and intra-seasonal drought are not of limiting consequence, and that the amount of precipitation and length of growing season are within bounds; despite the fact that such meteorological data when tabulated may seem hopeless.

30. We may say that agriculture entirely dependent on the rainfall could be successful as a subsidiary undertaking where the annual rainfall exceeds 25 inches, making possible the production of hay, grain, both cereal and pulse, and what may be vitally important for seasonal temperate vegetable culture, a satisfactory green manure crop.

Crop Production Under Varying Soil Types.

31. Crop production has been attempted on three soil types:

i. River alluvial or levee soil.
ii. Heavy, so called black soil.
iii. Light, so called sandy soil.

32. Results from the levee soil indicate that initially thorough preparation and later frequent cultivation throughout the growth period is essential for satisfactory returns. We have also been able to record strikingly better results from crops following irrigated pasture than from those grown on virgin ground.

33. Limited evidence from black soil indicated that initial thorough preparation and subsequent cultivation is not so essential for success and that such soil tends to exhibit a greater natural fertility than the levee soil.

34. Finally our initial dealings with sandy soil show that it is essentially poor with perhaps very restricted usefulness.

Irrigation of Crops.

35. Little work has been carried out as regards the large scale irrigation of crops. However, there is evidence to show that the amount of water required under a system of furrow irrigation would be directly comparable with the optimum moisture requirements of similar crops under rain grown conditions, provided, and this is certainly essential when dealing with levee soils—cultivation is considered a necessary compliment of watering.

Factors Limiting Crop Productivity.

36. When considering the prospects of crop culture whether irrigated or not, during the summer and early autumn, that is between December and May, we are forced to face the fact that the grasshopper will be a most serious limiting factor, rendering successful results rather precarious. The grasshopper must be controlled.

37. Further factors limiting crop productivity are firstly, the chemical fertility of the soil and secondly of even greater significance, the physical structure of the soil.

38. There is every reason to believe that a healthy alternation between cropping and pasture would adequately deal with the latter factors without imposing any economic strain.

39. Agronomically we could expect the concept of "semi-permanent" pasture as a function of mixed farming, to fulfil a variety of needs. Needs which are obvious for so called red soils even in their virgin state. Needs which would, it is thought, become apparent over the black soil areas within a short period if simple cropping be the rule.

40. Viewing but one aspect of the situation, a short term grass pasture could be looked upon as essentially a drain crop to precede cotton culture, or on the other hand a short term pure lucerne pasture could be looked upon as a storage

proposition to precede an arable rotation involving crops with a higher nitrogen requirement. The question is, however, more complex, in as much as both types of pasture would be of greater value in improving the soil structure and maintaining that structure.

41. It seems that within this tropic environment we would have to choose between a fertility conserving programme, involving a pasture-crop rotation supporting a varied stable economy or, the result of continued cropping for even a few years, a structureless dust or pug, subject to erosion, incapable of absorbing an adequate amount of moisture or air, resisting root penetration and quite dependent on the application of artificial fertiliser for any results.

PART IV.—VEGETABLE CULTURE.

42. Some work has been carried out in connection with vegetable production. Cultural aspects of this activity follow the same general pattern as for farm crops already discussed.

43. When production is considered on the scale of the home gardener or small market gardener, it is felt, because of the scope for intensive management as regards manuring and rotation, that a "garden area" could be kept in constant crop production.

44. Large scale vegetable culture with possibly no great scope for rotation, should for reasons already enumerated be considered as a function of mixed farming.

45. Owing to insects and likely unfavourable climatic conditions, early vegetable planting must be from seedlings reared in insect proof frames arranged in a somewhat shaded position. Later in the season considerable success could result from the direct planting of seed into permanent positions.

46. Satisfactory results can be assured by watering not more often than once a week. Under existing soil conditions, where the watering of short crop rows is frequent, it appears that some modification of the orthodox furrow method of irrigation is required. Better results have been obtained from the direct application of water to the plant than through watering by means of furrows at the side of the plant.

Suitability of Vegetable Crops Under Trial.

47. The following analysis gives some idea of the possible scope of activity:—

I. Outstandingly suitable with a wide range of production:
Sweet potato, pumpkin, tomato, Chinese cabbage, goyda bean, snake bean, watermelon.

II. Outstandingly suitable for growth during autumn, winter and early spring:
Onions, cabbage, beetroot, silver beet, turnip, kohlrabi, green peas, cucumber, rockmelon, sweet corn, carrot and culinary herbs.

III. Requiring special cultural stimulus for success with a rather restricted season:
Lettuce, cauliflower and celery.

48. There is no reason to suppose that sufficient vegetables of quite a varied and healthful order should not be available throughout the year. Tomatoes, a most acceptable vegetable, could with little special attention remain in season

between late June and January. January to May could be considered lean months with at least the following to be called on:—Sweet potato, snake bean, goyda bean, Chinese cabbage, bugle pumpkin (all suitable for production during this period), together with onions and pumpkins out of store.

PART V.—FRUIT CULTURE.

49. Little work has been carried out with regard to fruit culture. It seems that we are only in a position to say that papayas and bananas may be grown successfully and with ease. Pineapples, tried in a very restricted way have not flourished. It may be that, for their successful culture under our particular conditions, special means of reducing the prevailing alkalinity of the soil would have to be adopted. The application of sulphur could possibly be a means to this end. An effort is being made to grow passion fruit. With special attention plants have survived their first summer; they should grow vigorously and produce fruit with the onset of cooler weather.

50. Probably the scope of fruit culture will be quite restricted to tropical and semi-tropical types. A list of those which should be quite adaptable to our conditions follow:—

(i) The citrus fruits.
(ii) Banana and plantain.
(iii) Papaya.
(iv) Custard apple.
(v) Mango.
(vi) Pineapple.

These have already proved their suitability in gardens of the Kimberleys and Territory.

(vii) Avocado.
(viii) Granadilla.
(ix) Monstera deliciosa.
(x) Passion fruit.

51. Concern is often expressed as to the suitability of citrus fruits, because of their susceptibility to white ant attack. Control would be necessary, but it is hardly conceivable that such would not prove thoroughly effective, especially when we think in terms of a well planned and carefully prepared orchard rather than the odd tree in a garden corner.

PART VI.—FERTILISER EXPERIMENTS.

52. Manurial trials have been instituted at various times throughout our investigations.

53. In the original layout a replicated experiment involving the three manures, blood and bone, sulphate of ammonia and superphosphate, together with control areas receiving no treatment, yielded no positive result whatever. The resultant growth was comparable in all cases, even and vigorous.

54. Superphosphate was looked upon as the most likely immediate manurial requirement, as a general practice therefore, most of the area in the course of establishment was arranged to fit the requirements of a simple experiment. One third of the various pastures received no treatment, another third received 1 cwt. of superphosphate per acre and the final third 2 cwt. of superphosphate per acre.

55. Results showed that superphosphate did stimulate the growth of pastures in a minor degree, with nothing to justify any further claims.

56. As time progressed it became very obvious that all pure grass swards were suffering from a serious deficiency. The fact that grass when intimately mixed with lucerne was very much more productive, together with other observations, provided the clue which lead us to the conclusion that the major factor operating against the continued satisfactory maintenance of yield, when dealing with irrigated grass pasture, was simply a lack of available nitrogen. Subsequent evidence has fully supported this finding and further lead us to the proposition, that permanent pasture demands legume admixture.

57. It is not at the moment expected that direct manurial treatment with nitrogenous fertilisers would be economically feasible. It is felt, however, that the normal fertility of the soil could, with adequate cultural practices, be raised to a point where semi-permanent irrigated grass swards would become a profitable undertaking.

58. Lack of nitrogen leads to a host of related troubles, the most spectacular being the rapid failure of paspalum through "grass grub" attack once a certain stage of deterioration has been reached.

59. So far it appears that lucerne will not react to manurial stimulus. Where lucerne is not suffering from disease, there is nothing to indicate that it is not thoroughly catered for in all its requirements. Where disease is rampant, application of superphosphate, blood and bone, potash, and sulphate of ammonia, together with minor elements, alone and in combination have as yet had no observable effect.

60. Blood and bone has given good results in vegetable production.

61. Up to the present we have asked our farm crops to grow without manurial treatment. Results have been quite satisfactory, with nitrogen alone showing up as a factor worthy of immediate attention.

62. Summing up, we may say that at least during the first years of intensive exploitation the soil presents no serious limitations. Lack of available nitrogen and an attendant problem, lack of humus, is quite understandable within a tropic environment and should be adequately catered for without direct applications of fertiliser. It can be noted that lucerne-grass mixtures which have as yet received no manure are, after three years, among the few remaining highly productive areas.

FERTILISER EXPERIMENT, NOVEMBER, 1944.

Irrigated Grass Pasture.

Treatment. Fertiliser and Rate.	*Yield—Lb. green material per acre.		
	Paspalum (*Paspalum dilatatum*)	Molasses grass (*Melinis minutiflora*)	Rhodes grass (*Chloris gayana*)
No manure	2,722	3,932	3,932
P2	3,026	...	...
K1	2,722	...	...
N1	5,596	6,806	12,100
N2	11,344	17,242	19,965
N2 P1, K1	8,167	...	...
N1, P1, K1	6,352	...	15,881
N1, P2	...	6,050	14,520

P2	Superphosphate 2 cwt. per acre.
K1	Sulphate of potash 1 cwt. per acre.
N1	Sulphate of ammonia 1 cwt. per acre.
N2	Sulphate of ammonia 2 cwt. per acre.

* Yields taken 5½ weeks after application of manures.

PART VII.—ENTOMOLOGICAL ASPECTS.

64. Innumerable pests, grubs, caterpillars, moths, thrips, aphis, jassid hoppers, termites, ants, grasshoppers, crickets, weevils, beetles, mealy bugs and no doubt many others may be regarded as potential enemies, together with stock pests, principally the buffalo fly and the tick. However, only three have been present to date in sufficient concentration to defy simple control measures and shed any gloom on the prospects of economic development.

65. The first is a jassid leaf hopper, which in one year only, inflicted very severe damage on lucerne during a full month of spring. The second is the buffalo fly. Between January and the end of April it is a source of extreme irritation to both cattle and horses and is responsible for serious loss of condition during the height of attack. It may be noted that buffalo fly traps have proved effective. For a small undertaking, typically a dairy farm and as an adjunct to stables or horse paddock traps would be essential at least until such time as future research can suggest a more direct means of control. The third is the grasshopper for which considerable concern has already been expressed. It, in its various forms, is a devastating menace to all cultivated vegetation, banana and pineapple no less than grass and lucerne.

66. Grasshopper control has been the subject of much investigation throughout the world. Although thorough local study of the problem is essential, it is thought that many of the findings of outside research would have direct application.

PART VIII.—PATHOLOGICAL ASPECTS.

67. Except in the case of lucerne and to a very minor extent in the case of papayas and tomatoes, disease has to date, not operated against the full development of plants.

68. A diseased condition which is responsible for widespread damage to lucerne stands during their second year of production, closely resembles what is considered a virus infection, known in other parts of Australia as "little leaf," "bunchy top" or "witches broom."

69. Such names are quite suggestive of the main symptoms. The bunched shoots much reduced in size are sickly in colour, with the minute leaves of seriously effected plants, often distorted by curling.

70. The same general symptoms have been noted in certain other cultivated legumes (pigeon pea, peanut and *centrosema pubescens*) and native plants (Cleome, Physalis, Crotalaria, and Rhynchosia).

71. Observations of significance are:—

I. The disease does not kill quickly.

II. There is a marked tendency for affected plants to recover during the ideal growing conditions of winter and early spring.

III. Areas receiving what could be termed an excess of water do not suffer as readily as areas receiving less water.

IV. The months November and December seem to favour a rapid spread of the disease and plant mortality is high during this period.

V. Pure lucerne stands suffer very much more seriously than mixed grass and lucerne pasture.

VI. Lucerne grown in rows three feet apart was the first area to show symptoms and finally collapse.

The fact that this disease is of considerable economic importance cannot be denied, but at the same time we must admit that lucerne is capable of remarkable returns before the onset of the disease and that at least another year can be added to its very satisfactory existence, provided it is combined with a suitable grass—that is if the evidence we have before us is in any way a true indication. Further, there is yet no reason or supposing that the life of lucerne where associated with grass could not be prolonged indefinitely.

72. Lucerne it is felt will remain the major introduction for irrigated pasture. We have seen that although its maximum response is restricted to the late autumn, winter and spring months, it can produce heavily throughout every month of the year. Through its efforts we have produced a pasture capable of carrying 2½ beasts to the acre during the full twelve months; grass alone without specialised attention could not be expected to carry much more than ½ a beast to the acre.

73. *A comparative analysis*:

(A) Rhodes grass—Pure stand 1 year to 2 years old.
7-8 grazings per year.
0.8 beasts per acre carrying capacity.

(B) Lucerne—Pure stand 1 year to 2 years old.
10 grazings per year.
2.2 beasts per acre carrying capacity.

(C) Mixed pasture—stand 1 year to 2 years old.
Grass plus lucerne—one quarter of area a pure grass stand.
10 grazings per year.
1.75 beasts per acre carrying capacity.

(D) Mixed pasture—stand 1 year to 2 years old.
Grass plus lucerne.
10 grazings per year.
2.5 beasts per acre carrying capacity.

74. Perhaps extended research may be necessary before we will be able to take full advantage of lucerne's remarkable ability, perhaps on the other hand the solution of problems might prove quite a simple matter. Whatever the case, lucerne can and must be saved for the area.

75. It is possible to suggest the following as a basis for experimental operations directed towards overcoming disease in lucerne:—

I. The extent to which stooking practice may be responsible for upsetting the physiological processes of the lucerne plant.

II. The extent to which stock trampling may be responsible for direct damage to crowns.

III. Whether climatic factors are basically significant. (A study of the comparative environments at or near ground level in:—

(a) Lucerne under row conditions.

(b) Lucerne as a pure stand.

(c) Lucerne as a mixture with grass; could possibly lead to enlightening conclusions.)

IV. To what extent any established findings in the case of I, II, and III may be offset by management technique or mixture with a suitable grass.

V. Response of varying strains to the environment, besides Hunter River and Peruvian which are at the moment outstanding.

VI. The growth response from locally produced seed with a view to subsequent selection.

VII. Nutritional requirements.

76. It will be noted that here we have gone into some detail and it may be asked why other sections have been confined to broader outline with no lengthy recommendations for analytical research?

77. The answer is twofold. Firstly, we cannot say else than that we have but touched the fringe of our essentially exploratory task and secondly, if we may be excused from what might be termed over optimism, that questions other than a disease in lucerne, and the grasshopper menace, have not taken as yet and we trust never will take the form of obstacles that cannot be successfully bypassed if not entirely solved.

CONCLUSION.

78. Above all preliminary investigations have shown that, the particular climatic belt with which we have to deal is indeed a poor "mining proposition," that haphazard and/or casually transported cultural methods will result certainly in failure. Although the principles of agriculture apply equally for a temperate or tropical environment the successful application of the larger concept of agriculture in general is a matter of local understanding.

79. It has been said that "A question has meaning only when it is possible to find operations by which an answer can be given." It is so with the question of developing the North—operations must be found by which an answer can be given.

80. With such in view we may conclude with an all embracing recommendation:—

> That a research station be established to ascertain the scope of economic land utilisation and settlement in the Kimberleys and adjoining districts of Northern Australia.

Agricultural Broadcasts.

The following programme of Agricultural Talks has been arranged for the October-December quarter and will be broadcast from regional stations at 9.30 p.m. each Thursday:—

Date.	Talk Prepared by :	Title.	Summary.
	I.—FARMERS IN A CHANGING WORLD.		
Oct. 18	Dr. E. J. Underwood, Animal Nutrition Officer, Department of Agriculture	Is World Organisation of Agriculture Desirable ?	The need for Agricultural planning on an international as well as a national scale will be discussed. The structure and functions of the United Nations Office of Food and Agriculture in Washington as a basis for international planning of agriculture to avoid unwieldy surpluses and stimulate production according to world needs, will be described.
Nov. 15	C. A. Gardner, Government Botanist, Department of Agriculture	The Origins of Cultivated Plants III.	An account will be given of the distribution and origins of the more important cultivated plants.
Dec. 13	Dr. T. C. Dunne, Horticultural Research Officer, Department of Agriculture	Dried Foods ...	Consideration will be given to the possibiliites of expansion in the use of dried foods.
	II.—TOPICAL ITEMS.		
Oct. 25 Nov. 22 Dec. 20	G. K. Baron Hay, Under-Secretary for Agriculture, will discuss current events in agriculture.		
	III.—FARMERS' FORUM.		
Oct. 4 Nov. 1 Nov. 29 Dec. 27	Discussion on subjects submitted by farmers is arranged by A. M. Stewart, Lecturer in Agriculture, University of Western Australia		
	IV.—TECHNICAL TALKS.		
Oct. 11	C. F. H. Jenkins, Government Entomologist, Department of Agriculture	A Fruit Fly Jubilee	The importance of this pest to the fruit industry will be emphasised and control measures outlined.
Nov. 8	K. Needham, Dairy Bacteriologist, Department of Agriculture	Dairy Bacteriology	A description of bacteria and a brief history of dairy bacteriology. The beneficial and harmful effects of bacteria in dairy products.
Dec. 6	C. R. Toop, Senior Veterinary Surgeon, Department of Agriculture	Toxic Paralysis ...	Severe losses in cattle and sheep in summer months may be prevented by inoculation.

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